GHD

Marine Environmental Quality Management Plan

Koombana Bay Marine Structures SPER

South West Development Commission

8 January 2024

→ The Power of Commitment

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S1	1	Dr J. Romero	F. Hannon		F. Hannon		30/6/22
S4	2	Dr J. Romero	F. Hannon		F. Hannon		4/4/23
S4	3	Dr J. Romero	F. Hannon		F. Hannon		30/10/23
S4	4	Dr J. Romero, T. Sullivan	F. Hannon		F. Hannon		8/1/24

Executive summary

This Marine Environmental Quality Management Plan (MEQMP) fulfils requirements under the Western Australian Environmental Protection Authority's (EPA) Environmental Scoping Document (Assessment Number 2049) Items 2 and 7b for the proposed Koombana Bay Marine Structures (KBMS) development by the South West Development Commission.

This MEQMP is comprised of the following key elements to maintain the Marine Environmental Quality of Koombana Bay from operational activities upon completion of the proposed KBMS development:

– **Environmental Quality Plan (EQP):** The EQP establishes the Environmental Quality Management Framework under which the MEQMP is implemented. This includes defining the Environmental Values and Environmental Quality Objectives (EQOs) of Koombana Bay. Further, for the EQO for Maintenance of Ecosystem Integrity, Moderate (Marina, Harbours) and High (remainder of Koombana Bay) Levels of Ecological Protection are spatially defined. Environmental Quality Criteria verify whether the EQOs are met, and include Environmental Quality Guidelines (EQG, if compliant then high certainty EQO met) and Environmental Quality Standards (EQS, if non-compliant then high certainty EQO not met).

– **Routine Monitoring:** The routine monitoring program determines whether the EQGs are being met. If an EQG is not met (i.e. uncertainty whether EQO met), then Reactive Monitoring and Management is triggered.

– **Reactive Monitoring and Management:** The reactive monitoring program determines whether an EQS is met. If the EQS is met then the EQG non-compliance poses an acceptable low risk. A non-compliant EQS triggers reactive management to rectify an unacceptable risk to an EQO.

– **Implementation:** The implementation section provides general procedures and/or guidance for routine monitoring, reactive monitoring and management, reporting and reviews.

This report is subject to, and must be read in conjunction with, the limitations, assumptions and qualifications contained throughout the Report.

Contents

Table index

Figure index

Appendices

Acronyms and abbreviations

Acronym / Abbreviation	Description
Al	Aluminium
As	Arsenic
BCH	Benthic Community Habitat
BHD	Backhoe Dredge
BOOM	Bunbury Ocean Outfall Monitoring program
CBH	Casuarina Boat Harbour
Cd	Cadmium
CD	Chart Datum
CFU	Colony Forming Unit
Chl-a	Chlorophyll-a
Co	Cobalt
Cr	Chromium
Cu	Copper
DDC	Dolphin Discovery Centre
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DoH	Department of Health
DWER	Department of Water and Environmental Regulation
EAG	Environmental Assessment Guideline
EPA	Environmental Protection Authority
EQC	Environmental Quality Criteria
EQG	Environmental Quality Guideline
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objective
EQP	Environmental Quality Plan
EQS	Environmental Quality Standard
ESD	Environmental Scoping Document
EV	Environmental Value
Fe	Iron
FRP	Filterable Reactive Phosphorus
ha	Hectare
HEPA	High Ecological Protection Area
Hg	Mercury
IMS	Invasive Marine Species
ISQG	Interim Sediment Quality Guideline
KBMS	Koombana Bay Marine Structures
kg	Kilogram

Acronym / Abbreviation	Description
KEF	Key Environmental Factor
km	Kilometer
KBSC	Koombana Bay Sailing Club
l	Liter
LEP	Level of Ecological Protection
LEPA	Low Ecological Protection Area
LOI	Loss on Ignition
LoR	Limit of Reporting
m	Meter
m^3	Cubic Meter
MCMP	Marine Construction Management Plan
MEPA	Moderate Ecological Protection Area
MEQ	Marine Environmental Quality
MEQMP	Marine Environmental Quality Management Plan
mg	Milligram
ml	Milliliter
Mn	Manganese
Mo	Molybdenum
NH_X	Reduced inorganic nitrogen (ammonia plus ammonium)
Ni	Nickel
NO_X	Oxides of nitrogen (nitrate plus nitrite)
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
S	Salinity
Sb	Antimony
SPA	Southern Ports Authority
SPER	Strategic Public Environmental Review
SWDC	South West Development Commission
T	Temperature
TBT	Tributyltin
TBW	Transforming Bunbury's Waterfront
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TSS	Total Suspended Solids
µg	Microgram
V	Vanadium
WA	Western Australia
wt	Weight
Zn	Zinc

1. Introduction

1.1 Proposal

The South West Development Commission (SWDC) is the proponent for the Koombana Bay Marine Structures (KBMS) proposal. In March 2015 the SWDC referred the KBMS proposal to the Western Australia Environmental Protection Authority (EPA), which determined the KBMS proposal to be assessed at the level of “Strategic Proposal” (Public Environment Review or SPER). The EPA approved an Environmental Scoping Document (ESD) for the KBMS SPER (Assessment Number 2049) on 26 June 2015.

The KBMS proposal (or the strategic proposal) is located within the City of Bunbury, about 174 kilometres (km) south of Perth, Western Australia. The marine structures subject to the KBMS strategic proposal are situated within Koombana Bay which neighbours the Bunbury Central Business District and the Marlston North residential and waterfront developments. Figure 1 illustrates the indicative KBMS proposal.

The KBMS strategic proposal aims to construct and operate the following marine structures within Koombana Bay:

1. Casuarina Boat Harbour expansion.
2. Koombana Bay Sailing Club (KBSC) marina.
3. Dolphin Discovery Centre (DDC) finger jetty.

Collectively, the three (3) separate marine structures listed above are referred to as the KBMS strategic proposal. Individually, and because they will be constructed over different timescales, the three (3) individual marine structures are referred to as “future proposals”. This is consistent with the EPA’s assessment process and terminology under the *Environmental Protection Ac, 1986.*

1.1.1 General description of KBMS strategic proposal

A general description of the KBMS strategic proposal is provided in Table 1.

Table 1 General strategic proposal description

Strategic proposal title	Koombana Bay Marine Structures
Strategic proponent name	South West Development Commission
Short description	The strategic proposal is to develop areas in Koombana Bay for small craft marine infrastructure (Figure 1). The proposed marine infrastructure includes jetties, boat ramps and boat pens. The identified future proposals under the strategic proposal are for the construction and operation of: – **Casuarina Boat Harbour** – **Koombana Bay Sailing Club Marina** – **Dolphin Discovery Centre Finger Jetty** The construction of future proposals will be undertaken in stages. The marine infrastructure is located adjacent to, or in close proximity to existing infrastructure in Koombana Bay, Bunbury.

1.1.2 Identified future proposal description and elements

A description and elements of the KBMS future proposals are provided in Table 2.

Table 2 Identified future proposal description and elements

Casuarina boat harbour This future proposal includes a dredging and dredge spoil disposal, piling activities, land reclamation and construction of a breakwater and revetment walls. The marine infrastructure includes the construction and operation of floating jetties, boat ramps and boat pens.		
Proposal element	**Location / Description**	**Maximum Extent, Capacity or Range**
Physical elements		
Development Envelope	Figure 1	Up to 40 ha
(Indicative) Casuarina Boat Harbour (CBH) disturbance footprint	Figure 1	Up to 32 ha within CBH disturbance footprint
Breakwater	Figure 1	Up to 3.5 ha within CBH disturbance footprint
Reclamation	Figure 1	Up to 3.5 ha within CBH disturbance footprint
Marine infrastructure	Within CBH	Floating jetties, boat ramps and boat pens within CBH disturbance footprint.
Koombana Bay Sailing Club marina This future proposal includes a dredging component, a piling component, land reclamation (including onshore dredge spoil disposal) and construction of breakwaters. The marine infrastructure includes the construction and operation of floating jetties, boat ramps and boat pens.		
Proposal element	**Location / Description**	**Maximum Extent, Capacity or Range**
Physical elements		
Development Envelope	Figure 1	Up to 16 ha
(Indicative) Koombana Bay Sailing Club (KBSC) marina disturbance footprint	Figure 1	Up to 10 ha within KBSC disturbance footprint
Breakwaters	Figure 1	Up to 2.5 ha within KBSC disturbance footprint
Reclamation	Figure 1	Up to 2 ha within KBSC disturbance footprint
Marine infrastructure	Within KBSC	Floating jetties, boat ramps and boat pens within KBSC disturbance footprint
Dolphin Discovery Centre finger jetty This future proposal includes a finger jetty, a piling component and a temporary onshore construction laydown area.		
Proposal element	**Location / Description**	**Maximum Extent, Capacity or Range**
Physical elements		
Development Envelope	Figure 1	Up to 0.5 ha
(Indicative) Dolphin Discovery Centre (DDC) jetty disturbance footprint	Figure 1	Up to 0.15 ha within DDC disturbance footprint
Marine infrastructure	Figure 1	Jetty up to 110 metres long

Figure 1 ***Development envelope, indicative disturbance footprint and marine elements***

1.2 Purpose of this plan

This Marine Environmental Quality Management Plan (MEQMP) addresses the following ESD 2049 requirements for the key environmental factor (KEF) marine environmental quality (MEQ):

– **ESD 2049 KEF MEQ Item 2:** Provide an Environmental Quality Plan (EQP) that spatially defines the Environmental Values (EVs), Environmental Quality Objectives (EQOs) and Levels of Ecological Protection (LEPs) that currently apply to the area. The EQP is to be developed consistent with EPA's Environmental Assessment Guideline (EAG) No. 15 Protecting the Quality of Western Australia's Marine Environment.[1]

– **ESD 2049 KEF MEQ Item 7b:** A MEQMP that includes monitoring and management to ensure that the operation[2] of each of the future proposals achieves the proposed EQOs/LEPs defined in the revised EQP required by ESD 2049 KEF MEQ Item 2. The MEQMP should be based on the EPA's EAG No. 15 'Protecting the Quality of Western Australia's Marine Environment'.[1] The MEQMP will define the EVs to be protected, identify the environmental concerns or threats and establish the EQOs and LEPs to be achieved. It is also to include and detail the management and mitigation measures to ensure that the EVs and EQOs are achieved. The MEQMP is to consider the staging the identified future proposals to ensure that both future proposals will meet the EPA's objectives in the long term.

1.3 Limitations

This report: has been prepared by GHD for South West Development Commission and may only be used and relied on by South West Development Commission for the purpose agreed between GHD and South West Development Commission as set out in this report.

GHD otherwise disclaims responsibility to any person other than South West Development Commission arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

[1] The EQP is incorporated into this MEQMP, and is consistent with Technical Guidance (TG): Protecting the Quality of Western Australia's Marine Environment (EPA 2016), which has superseded EAG No. 15.
[2] ESD 2049 refers to 'construction and operation of each of the future proposals'. This MEQMP only addresses the operational aspects of the future proposals as they relate to the KEF MEQ. Management of construction aspects addressed in the Marine Construction Monitoring and Management Plan (MCMMP) RPS (2023b).

2. Existing and predicted future marine environmental quality

Koombana Bay is a large coastal embayment approximately 180 km south of Perth, which is partially enclosed by the Bunbury Peninsula and Point Casuarina. The bay is sheltered from prevailing wind and wave action from the south and south-west, and partly sheltered from north-westerly winter storms. Natural depths in Koombana Bay range up to 10 m. The deep (~15 m) Shipping Channel runs through the centre of the Bay to the Inner Harbour located in the south-east corner of the bay. The Casuarina Boat Harbour is situated along the western side of Koombana Bay. The Cut at the eastern margin of the bay is the opening to the Leschenault Estuary in which the two major regional rivers drain (Collie River, Preston River). The Plug in the southwestern corner of the bay connects with the Leschenault Inlet.

2.1 Metocean, hydrodynamics and flushing

Typical wind patterns are predominately southeasterly to southwesterly during the spring-summer (October-March), predominately westerly with periods of elevated winds corresponding to storm fronts during winter months (June- September), and typically seasonal low wind speeds occur during April-May.

Wave heights are generally greater in winter than summer in the coastal inshore waters just outside of the bay (Beacon 3) (Met Ocean Solutions 2008). The largest waves typically are locally generated from the northwest.

Because of the small range in the tidal water level variations (<1 m), winds have a strong influence on the currents in the bay (Hearn 1983, Hearn et al 1987, Hunter 1983, Hollingsworth 2006, Wave Solutions 2012a).

Median e-folding flushing times (the duration to exchange ~63% of a water body volume) over 1 year (2015-2016) of Casuarina Boat Harbour, Inner Harbour and Leschenault Inlet on the basis of three-dimensional (3D) hydrodynamic modelling are 2.2[3], 7.8 and 11.3 days, respectively (GHD 2023a). These are predicted to increase with implementation of the KBMS strategic proposal to 5.8 and 9.3 days for Casuarina Boat Harbour and Leschenault Inlet, respectively, with no predicted change to the flushing time of the Inner Harbour. The future KBSC marina is predicted to have a median flushing time of 5.0 days.

The increase in the flushing time of Leschenault Inlet from the KBSC marina future proposal was identified as a potential risk in regards to increased nutrient and chlorophyll-a (chl-a) levels. GHD (2023a) identified that a frequent clockwise boundary current occurs along Koombana Beach (westerly flow) and Jetty Road causeway (northerly flow). The predicted effect of the KBSC marina future proposal is to cause a northward and eastern shift of the current towards the interior of Koombana Bay, which reduces the transport (i.e. flushing) of the embayment between the causeway and KBSC marina. Hence, though the volumetric flux through the Plug into and out of Leschenault Inlet does not materially change, due to the reduced flushing of the embayment there is greater recirculation of inlet waters discharged during an ebb tide during the subsequent flood tide. This mechanism is the cause of the ‘effective’ increase in the flushing time by 1.5 days (~20%) of the inlet.

Changes to hydrodynamics (e.g. circulation patterns) were limited to western Koombana Bay in the immediate region of the KBSC marina future proposal (GHD 2023a) as described beforehand.

2.2 Water quality

Generally, vertically well mixed conditions in terms of temperature and salinity prevail in Koombana Bay. Salinity stratification can occur in response to high rainfall and river inflows via the Cut. Weak

---

[3] GHD (2023a) simulated a median flushing time of ~2.2 days of the existing Casuarina Boat Harbour volume from June 2015-May 2016. MP Rogers (2016) and WorleyParsons (2017) provide spatial e-folding times from a dye survey and modelling, respectively, but do not provide e-folding times of the entire harbour volume.

temperature stratification can occur during calm periods. Dissolved oxygen is generally at saturation levels and pH is ~8 (GHD 2023b). Daily median turbidity is generally low (<5 NTU) throughout the year except elevated river inflow events can lead to persistent elevated levels in the bottom waters, which typically occurs during winter into early spring (GHD 2023b). During summer the light attenuation coefficient (base 10) is typically ~0.2 1/m and increases to >0.4 1/m in response to river discharge events (GHD 2023b).

SKM (2009, 2010, 2011a, 2011b) surveys indicate that elevated dissolved zinc (Zn), copper (Cu) and to a lesser degree cadmium (Cd) in the water column of eastern Koombana Bay are influenced by the Inner Harbour, but are below the ANZG (2018) default guideline values for toxicants.

Baseline monitoring of Koombana Bay and Casuarina Boat Harbour from September 2016-September 2017 found many dissolved metal and metalloid analytes (aluminium [Al], chromium [Cr], manganese [Mn], iron [Fe], nickel [Ni], Cd and mercury [Hg]) were predominately at (or near) the laboratory limit or reporting (LoR), and well below the applicable ANZG (2018) default guideline values for toxicants, ANZECC (2000) toxicant trigger values or ANZECC (2000) low reliability trigger values (GHD 2023b). Cu, Zn, arsenic (As) and lead (Pb) had at least several measurements during the 2016-2017 baseline monitoring above the relevant ANZG default guideline values for toxicants (i.e. Cu, Zn, Pb) and ANZECC (2000) low reliability trigger values (i.e. As) (GHD 2023b). Zn was the only metal/metalloid during baseline monitoring of Leschenault Inlet from January-August 2020 that was above the ANZG (2018) default guideline value for this toxicant at a 95% species protection level of 8 ug/L (O2 Marine 2021), which was identified by GHD (2023b) as a potential toxicant that may limit algal levels in this water body. Generally, dissolved metals and metalloids concentrations in Koombana Bay and Casuarina Boat Harbour from 2016-2017 were similar to measurements in Koombana Bay and the Inner Harbour during February-October 2012 (Wave Solutions 2012b), which suggests no marked changes in the concentrations of these analytes over the intervening five (5) years.

Metals and metalloids, nutrients and chl-a measurements over the past 20 years within Koombana Bay, its adjacent water bodies (i.e. Inner Harbour, Casuarina Boat Harbour and Outer Harbour, Leschenault Inlet), and nearshore open coastal waters (often at the Southern Ports Authority [SPA] spoil grounds) were collated by GHD (2023c) and include:

- The Inner Harbour, Outer Harbour and the SPA spoil grounds approximately every two (2) years from 1998-2006 (SKM 1998, 2002, 2004, 2007a).
- Koombana Bay, Casuarina Boat Harbour and Leschenault Inlet quarterly from July 2007 to April 2008 (Oceanica 2008a).
- The Inner Harbour and Koombana Bay every 6-8 weeks from February-October 2012 for chl-a only (Wave Solutions 2012b).
- Triannually (3 times a year) at five (5) nearshore coastal reference sites 10-15 km to the south of Koombana Bay for the Bunbury Ocean Outfall Monitoring program (BOOM) (data provided by Water Corporation for nutrients and chl-a only).
- Koombana Bay and Casuarina Boat Harbour monthly to bi-monthly during the 2016-2017 baseline monitoring (GHD 2023b).
- Leschenault Inlet monthly for the 2020 baseline monitoring (O2 Marine 2021).

The medians and 80^{th} percentiles of nutrient and metals/metalloids data of the KBMS strategic proposal baseline data are provided in Table 3 from GHD (2023b). The following is noted in regards to a comparison of the nutrient and chl-a climate among the various water bodies (open nearshore coastal, Koombana Bay, Casuarina Boat Harbour, Leschenault Inlet):

- The 2005-2016 nutrients from the BOOM reference sites (proximal exposed inshore waters to the south) met the appropriate ANZG (2018) and ANZECC (2000) guideline/trigger values for marine waters, whereas the 80^{th} percentiles of inorganic reduced nitrogen (NH_X), inorganic oxidised nitrogen (NO_X) and total phosphorus (TP) were greater than these criteria. Similarly, chl-a at the BOOM reference sites met the appropriate ANZG (2018) guideline values, however levels in Koombana Bay were substantially greater than the coastal waters by a factor of 6-8.
- The nutrient levels increase along the gradient of Koombana Bay, Casuarina Boat Harbour and Leschenault Inlet (Table 3) where:

- Two (2) medians (NH_X and TP) and two (2) 80th percentiles (NO_X, TP) do not meet the guidelines in the harbour.
- Four (1) medians (NH_X, TP, NO_X, filterable reactive phosphorus [FRP]) and one 80th percentile (total nitrogen [TN]) do not meet the guidelines in the inlet.
- The most substantive increase along this nutrient climate gradient was for NH_X in the inlet where the median and 80th percentile are factors of ~7 and ~9 greater than the harbour, respectively.

– Though there is a clear nutrient climate gradient amongst these water bodies, this is not manifested to the same degree in terms of the algal standing stocks (Table 3). Total suspended solids (TSS) between the water bodies (Table 3) and estimates of daily light attenuation coefficients in the inlet and bay (GHD 2023b) are similar so that light limitation of primary productivity is an unlikely causal factor. However, Zn toxicity via groundwater inputs in Leschenault Inlet may be a causal factor in reducing phytoplankton productivity in this water body.

Zn in Leschenault Inlet was the only metal/metalloid with median and 80th percentile concentrations from the O2 Marine (2021) baseline data that were above the ANZG (2018) default guideline value for toxicants in waters. GHD (2023b) identified that this toxicant may potentially limit algal productivity in the inlet. The average Zn groundwater concentration of 0.21 mg/L (RPS 2017a) was estimated to account for approximately 80% of the median concentration in eastern Leschenault Inlet (GHD 2023b) and thereby the likely primary source into this water body. Zn levels in the sediments of Leschenault Inelt are below the ANZG (2018) default guideline value for toxicants in sediments (see Section 2.3), so the sediments are not a primary source.

The key findings from the GHD (2023a) three-dimensional numerical modelling include:

– The physical oceanographic interaction between the open nearshore coastal waters with low nutrient and chl-a levels have limited penetration into Koombana Bay (i.e. Koombana Bay is sheltered from interaction with nearshore coastal waters).

– Other physical processes that promote the observed spatial variability in the nutrient and chl-a climate include:

- The jet that forms from the Cut during ebb tides often extends across the northern extent of Koombana Bay thereby forming a frequent temporary barrier for exchange of bay and offshore waters.
- The formation, and at times persistence, of two gyres in the western and eastern halves of the bay tend to recirculate waters within the bay (i.e. reduce exchange with the offshore waters than if the gyres did not form).
- The Shipping Channel tends to have currents aligned with the two bay gyres, which acts as an additional spatial barrier at times to reduce exchange of Koombana Bay with the offshore waters.
- Exchange of the semi-enclosed water bodies of Koombana Bay are limited by constricted openings with concomitant reduced flushing and increases in nutrient and chl-a levels relative to the bay.
- The transport of Leschenault Estuary waters (a relatively productive system with an elevated nutrient and chl-a climate relative to the open nearshore waters) into Koombana Bay (as well as the open nearshore waters) frequently occurs during ebb tides.

Table 3 *Median and 80th percentile of Koombana Bay, Casuarina Boat Harbour and Leschenault Inlet water quality where yellow and pink shading indicate 80th percentile and median greater than default guideline value, respectively.*

Analyte	Guideline Value	2005-2016 BOOM open coastal nearshore Median (80th percentile)	2016-2017 Koombana Bay Median (80th percentile)	2016-2017 Casuarina Boat Harbour Median (80th percentile)	2020 Leschenault Inlet Median (80th percentile)
NHx	ANZECC (2000) 5 ug/L	1.5 (1.8)	3 (8.2)	6 (9.2)	40 (80)
NOx	ANZG (2018) 3.1 (sum), 6.1 (aut), 7.5 (win) & 2.6 (spr) ug/L	3 (4)	1 (9.2)	3 (10)	5 (30)
TN	ANZECC (2000) 230 ug/L	125 (160)	160 (200)	180 (232)	200 (400)
FRP	ANZG (2018) 5.5 (sum), 5.3 (aut), 6.2 (win) & 4.7 (spr) ug/L	1 (3.2)	3 (3)	3 (4)	5 (5)
TP	ANZECC (2000) 20 ug/L for summer (40 ug/L for winter)	10.5 (12)	19 (22)	24 (27)	30 (40)
Chla	ANZG (2018) 0.27 (sum), 0.55 (aut), 0.71 (win) & 0.36 (spr) ug/L	0.3 (0.5)	2.3 (3)	3 (3.8)	2 (4)
TSS			4 (7)	6 (10.6)	3 (9)
Al			2.5 (5)	2.5 (5.4)	5 (5)
Cr	ANZG (2018) 99th percentile species protection level for CrIII 4.4 ug/L		0.1 (0.1)	0.1 (0.1)	0.5 (0.5)
Mn	ANZG (2018) Unknown 80 ug/L		2.6 (3.4)	3 (4.1)	5 (5)
Fe	ANZECC (2000) Low Reliability Value18 ug/L		1 (1)	1 (2)	5 (10)
Ni	ANZG (2018) 95th percentile species protection level 7 ug/L		0.2 (0.3)	0.2 (0.3)	0.5 (0.5)
Cu	ANZG (2018) 95th percentile species protection level 1.3 ug/L		0.5 (0.6)	0.9 (1)	0.5 (1)
Zn	ANZG (2018) 95th percentile species protection level 8 ug/L		2 (3)	2 (3)	8 (49)
As	ANZG (2018) Low Reliability Value for AsIII 2.3 ug/L		1.8 (2)	1.8 (2)	2 (2)
Cd	ANZG (2018) 99th percentile species protection level 0.7 ug/L		0.5 (0.5)	0.5 (0.5)	0.5 (0.5)
Pb	ANZG (2018) 95th percentile species protection level 4.4 ug/L		0.2 (0.6)	0.1 (0.3)	0.5 (0.5)
Hg	ANZG (2018) 99th percentile species protection level 0.1 ug/L		0.05 (0.05)	0.05 (0.05)	0.05 (0.05)

There are a number of other operational activities within the Koombana Bay marine environment that may contribute to elevated nutrients and chl-a including (but not limited to):

- Port activities associated with the Inner Harbour.
- Nutrient (e.g. sullage) and contaminant (e.g antifoul, hydrocarbons) sources from recreational vessel.
- Irrigation runoff with nutrients from fertilisers, and potentially herbicide and pesticide toxicants.
- Nutrient fluxes from the Bunbury drainage network into Leschenault Inlet are unknown (GHD 2023a).

2.3 Sediment quality

Past sediment quality surveys (SKM 2007b, Oceanica 2008b, SKM 2008, SKM 2009, SKM 2010, Oceanica 2011, SKM 2011a, SKM 2011b, Wave Solutions 2012c, MARFL 2015) indicate that potential contaminants of concern in the Casuarina Boat Harbour and Koombana Bay are Sb, As and tributyltin (TBT) (refer to GHD [2023c] for review of past studies). However, exceedances were limited to the ANZG (2018) default guideline values for toxicants in sediments and not the ANZG (2018) high default guideline values.

Past sediment monitoring of total polycyclic aromatic hydrocarbons (PAHs) (Oceanica 2008b, SKM 2011a, SKM 2011b, Wave Solutions 2012c, MAFRL 2015), total petroleum hydrocarbons (TPHs) (SKM 2011a, SKM 2011b, Wave Solutions 2012c, MAFRL 2015), organochlorine pesticides (Oceanica 2008b, Wave Solutions 2012c, MAFRL 2015) and organophosphate pesticides (Oceanica 2008b, Wave Solutions 2012c) were below the NAGD (2009) screening levels.

Recent investigations of the sediment quality of Casuarina Boat Harbour (RPS 2017b), the proposed KBSC marina (Cardno 2021), and Leschenault Inlet (O2 Marine 2021) found:

– A small pocket of sediments in Casuarina Boat Harbour (~10,000 m^3) (RPS 2017b) was determined to present elevated TBT risk for offshore disposal, which will undergo onshore disposal.
– The proposed KBSC marina footprint has good sediment quality (Cardno 2021) with limited risk in terms of toxicity to the marine environment during the proposed dredging activities.
– O2 Marine (2021) sampling of Leschenault Inlet indicated the sediments do not pose a material risk to the environment in terms of metals and metalloids, TBT and OC/OP. Specifically, Zn was well below the ANZG (2018) default sediment guideline value for this toxicant and thereby is unlikely to be the source of elevated levels in the inlet.

2.4 Benthic communities and habitats

RPS (2017, 2023a) mapped the extent of benthic communities and habitats within Koombana Bay and the coastline adjacent to Bunbury based on the interpretation of aerial imagery, ground truthing field observations and findings from previous studies. Five (5) benthic habitat classes were documented, including

– Seagrass habitat comprised of *Heterozostera* sp. mixed with varying degrees of underlying *Halophila* sp. along the majority of the inshore area of Koombana Bay (but absent from Casuarina Boat Harbour), predominantly at depths between 1.0 - 3.0 metres (m).
– Assemblages of brown, green and red macroalgae, including canopy-forming brown macroalga (*Sargassum* sp.*),* attached to reef along the shore between the Dolphin Discovery Centre and the entrance channel to the Inner Harbour to a depth of approximately 1.5 m, as well as on discrete areas of reef approximately 1.5 kilometres (km) south-east and approximately 1.0 km east of the channel to Leschenault Estuary.
– Filter feeder communities (predominantly sponges) on a nearshore reef 0.5 - 1.0 km north-east of the channel to Leschenault Estuary.
– Several areas of turf algae interspersed along the shore at depths between 3.0 - 4.0 m.
– Bare sediment habitat throughout Casuarina Boat Harbour and at all depths greater than 4.0 m throughout the rest of Koombana Bay.

2.5 Primary and secondary contact

Koombana Bay is used for a range of human activities that involve primary and secondary contact including, but not limited to:

– Swimming and wading at beaches (Koombana Beach, Casuarina Boat Harbour Beach).
– Swimming with dolphins via Dolphin Discovery Centre tours.
– Water skiing, jet skiing and paddle craft.
– Fishing.

3. Environmental quality plan

3.1 Environmental Protection Act 1986

The Environmental Protection Authority exercises its powers under the *Environmental Protection Act 1986* (Government of Western Australia 2020). Section 44 (2) establishes that the EPA must make references to key environmental factors when assessing the potential environmental impacts of a referred proposal.

Environmental factors are those parts of the environment that may be impacted by an aspect of a proposal or scheme. The EPA has 14 environmental factors, organised into five themes: Sea, Land, Water, Air and People. The factors and objectives for sea are set out in Table 4.

Table 4 Environmental factors and objectives for theme 'Sea' (EPA 2020)

Theme	Factor	Objective
Sea	1. Benthic Communities and Habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.
	2. Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.
	3. Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.
	4. Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.

Of particular relevance to this MEQMP is the factor marine environmental quality. This is the key EPA consideration around which this MEQMP has been designed.

3.1.1 Marine environmental quality

Marine environmental quality refers to the level of contaminants in water, sediments or biota or to changes in the physical or chemical properties of waters and sediments relative to a natural state. In the context of marine water quality, emissions or discharges that can cause water quality deterioration are the key considerations. For the KBMS Strategic proposal, potential operational impacts to water quality will be monitored and managed by this MEQMP.

3.1.2 Coastal processes

A coastal process management plan (GHD 2023d) has been prepared to monitor and manage coastal processes in the vicinity of the KBMS Strategic proposal.

3.1.3 Benthic communities and habitats

A marine construction monitoring and management plan (RPS 2023b) has been prepared to monitor and manage benthic communities and habitats during construction of the KBMS Strategic proposal.

3.1.4 Marine fauna

A marine fauna management plan (RPS 2023c) has been prepared to manage potential operational impacts to marine fauna from the KBMS Strategic proposal.

3.2 Environmental quality management framework

This MEQMP adopts the environmental quality management framework (EQMF) of EPA (2016) for Western Australian marine waters as illustrated in Figure 2.

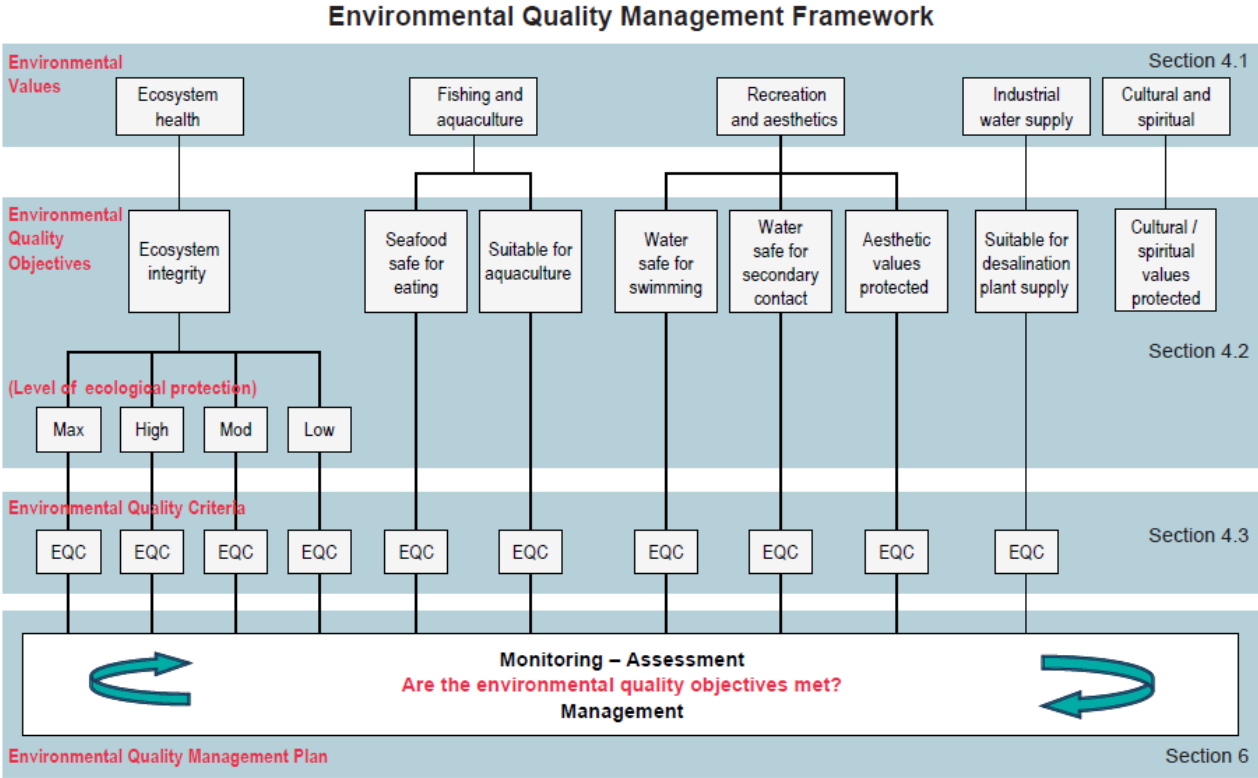

Figure 2 EQMF for Western Australian marine waters (EPA 2016)

The key elements of the EQMF are environmental values (EVs), environmental quality objectives (EQOs) and environmental quality criteria (EQC) as described in Table 5.

Table 5 Framework for target setting

Element	Description
Environmental Value (EV)	Establish a broad area of ecological or social importance to the stakeholders
Environmental Quality Objective (EQO)	Specify the stakeholder aspirations for specific management objectives for each Value
Environmental Quality Criteria (EQC)	Benchmarks that indicate level of performance in meeting objectives as monitored outputs or measured inputs

3.2.1 Environmental values and objectives

EVs and EQOs identified for the KBMS Strategic proposal are summarised in Table 6. This environmental quality plan (EQP) explicitly identifies different areas of ecological protection, specifically the EV of ecosystem health and the EQO of maintenance of ecosystem integrity. All other relevant EVs (Cultural and Spiritual, Industrial Water Supply) will be protected everywhere outside of the moderate ecological protection area (MEPA, refer to Section 3.2.3).

Table 6 EVs and EQOs for Koombana Bay waters

EVs	EQOs and Descriptions
Ecosystem Health	**Maintenance of ecosystem integrity** Marine ecosystem integrity is considered in terms of structure (e.g. the biodiversity, biomass and abundance of biota) and function (e.g. food chains and nutrient cycles) to an appropriate level.
Fishing and Aquaculture	**Maintenance of seafood safe for human consumption** Seafood is safe for human consumption when collected.
Recreation and Aesthetics	**Maintenance of primary contact recreation values** Primary contact recreation (e.g. swimming) is safe to undertake.
	Maintenance of secondary contact recreation values Secondary contact recreation (e.g. boating) is safe to undertake.
	Maintenance of aesthetic values The aesthetic values are protected.
Cultural and Spiritual	**Cultural and spiritual values of the marine environment are protected** Indigenous cultural and spiritual values are not compromised.
Industrial Water Supply	**Maintenance of water quality for industrial use** Water quality is suitable for *potential future* industrial use.

3.2.2 Environmental quality criteria

While the EQOs are qualitative with narrative descriptions, the EQC are quantitative and provide a basis to measure environmental quality performance. The EQCs are based on pressure-response relations of the operational activities of the KBMS Strategic proposal as described in Section 3.3.1. The EQC define the limits of acceptable change to environmental quality (expressed narratively as the EQOs), whereby EQC compliance assumes EQO achievement. The two types of EQC are:

– **Environmental Quality Guideline (EQG)**: Threshold numerical value(s) or narrative statement(s) when satisfied indicate a high degree of certainty that the associated EQO is achieved. If not satisfied then assessment against an environmental quality standard(s) (EQS) is triggered because of uncertainty as to whether the associated EQO has been achieved.

– **Environmental Quality Standard (EQS)**: Threshold numerical value(s) or narrative statement(s) when not satisfied indicate a significant risk that the associated EQO is not achieved, and with continued EQS exceedance a management response is triggered.

EQG and EQS use indicators closer to the pressure and response ends of the pressure-response relation, respectively. The conceptual framework for applying EQC is illustrated in Figure 3.

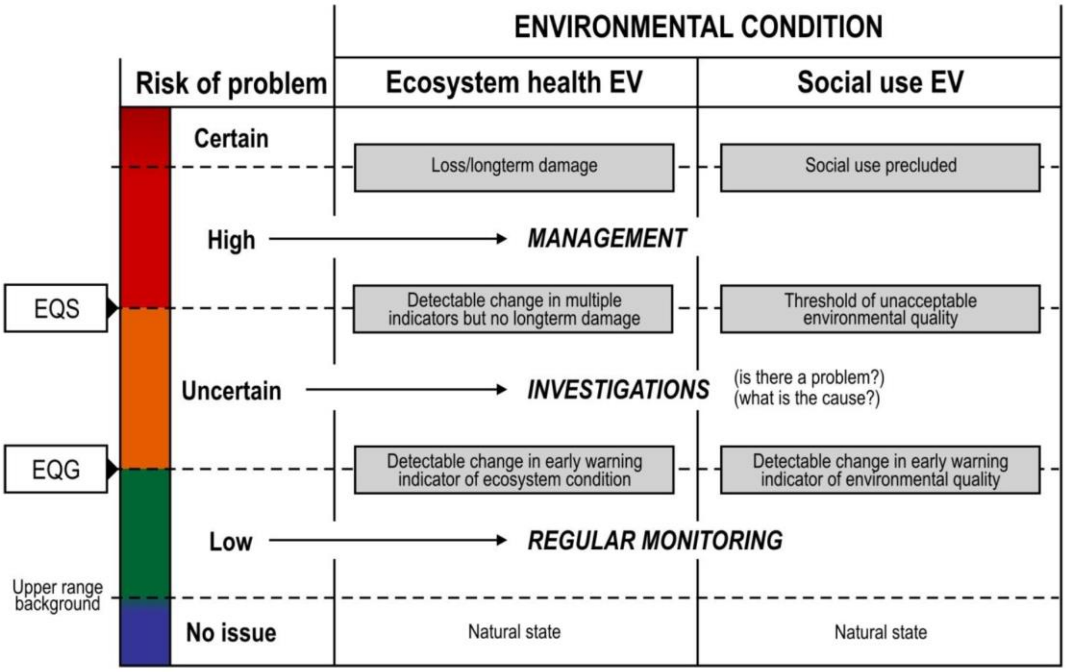

Figure 3 ***Conceptual diagram of relation between the two types of EQC (EQG and EQS shown on left) and associated environmental condition (shown on the right) (EPA 2016)***

3.2.3 Levels of ecological protection for the ecosystem health environmental value

Four levels of ecological protection (LEPs) can be spatially applied to represent the minimum acceptable level of MEQ to be achieved through management:

- **Maximum LEP Area (Maximum Ecological Protection Area)**: Allowance for no changes in the quality of water, sediment or biota (e.g. no changes in contaminant concentrations with no resultant detectable changes beyond natural variation in the diversity of species and biological communities, ecosystem processes and abundance/biomass of marine life).
- **High LEP Area (High Ecological Protection Area or HEPA)**: Allowance for small changes in the quality of water, sediment or biota (e.g. small changes in contaminant concentrations with no resultant detectable changes beyond natural variation in the diversity of species and biological communities, ecosystem processes and abundance/biomass of marine life).
- **Moderate LEP Area (Moderate Ecological Protection Area or MEPA)**: Allowance for moderate changes in the quality of water, sediment and biota (e.g. moderate changes in contaminant concentrations that cause small changes beyond natural variation in ecosystem processes and abundance/biomass of marine life, but no detectable changes from the natural diversity of species and biological communities).
- **Low LEP Area (Low Ecological Protection Area or LEPA)**: Allowance for large changes in the quality of water, sediment and biota (e.g. large changes in contaminant concentrations causing large changes beyond natural variation in the natural diversity of species and biological communities, rates of ecosystem processes and abundance/biomass of marine life, but which do not result in bioaccumulation/ biomagnification in near-by high ecological protection areas). [4]

As described in EPA (2016), ANZECC (2000) (now ANZG (2018)) recognises and provides guidelines for three (3) of the four (4) LEP types (noting no change allowed in the Maximum LEP area) that are the basis for the EGQs, namely:

[4] The fourth category of LEP, namely ‘Low’, generally only occurs in the immediate region of outfalls (e.g. wastewater or desalination) and is not currently applicable to Koombana Bay.

– Undisturbed (i.e. HEPA) where:

- Recommended 99% species protection guideline trigger levels for toxicant in waters (except 95% species protection level for cobalt (Co)).
- Interim Sediment Quality Guideline (ISQG) -low guideline trigger levels for toxicants in sediments, which is superseded here by the ANZG (2018) default guideline values for toxicants in sediments.
- The 80th percentile and/or 20th percentile of the data distribution for a suitable relatively unmodified reference site for the physical and chemical stressors or the default guideline trigger value provided.

– Slightly to moderately disturbed (i.e. MEPA) where

- Recommended 90% species protection guideline trigger levels for toxicant in waters.
- ISQG-low guideline trigger levels for toxicants in sediments, which is superseded here by the ANZG (2018) default guideline values for toxicants in sediments.
- The 95th percentile and/or 5th percentile of the data distribution for a suitable relatively unmodified reference site for the physical and chemical stressors.

– Highly disturbed (i.e. LEPA).

- For toxicants with potential to adversely bioaccumulate or biomagnify, the recommended 80% species protection guideline trigger levels for toxicant in waters.

3.3 EQMF implementation

3.3.1 Pressure-response conceptual model

The pressure-response conceptual model for operational activities associated with the KBMS strategic proposal is illustrated in Figure 4. The conceptual model was developed on the basis of a qualitative risk assessment (Appendix A) that was informed by three-dimensional numerical modelling (GHD 2023a) of the future proposals, baseline water quality monitoring (GHD 2023b) and a review of past monitoring data (GHD 2023c). A brief overview of the dominant pressure-response pathways is provided next.

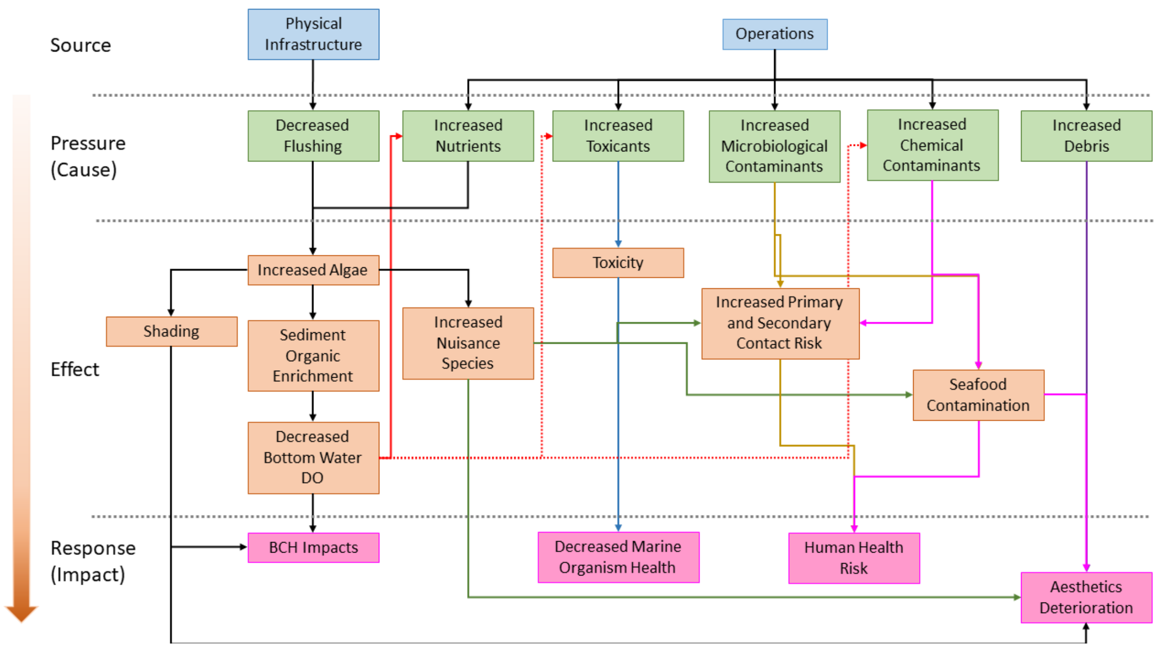

Figure 4 Conceptual pressure-response model of operational activities from the KBMS proposal

3.3.1.1 Pressures: decreased flushing and increased nutrient fluxes

The KBMS strategic proposal will reduce flushing of the two existing water bodies (Casuarina boat harbour, Leschenault Inlet). The addition of the northern breakwater to the existing northern opening of Casuarina Boat Harbour will increase its median flushing time[5] from 2.3 to 5.8 days (GHD 2023a). The proposed KBSC is predicted to have a median flushing time of 5.2 days (GHD 2023a). The Leschenault Inlet's median flushing time is predicted to increase from 7.9 to 9.5 days due to the presence of the KBSC marina, which is predicted to increase recirculation of inlet waters during flood tides from the embayment to the north of the Plug (between Marlston Waterfront and the KBSC marina) (GHD 2023a). There are negligible predicted effects of the KBMS strategic proposal on flushing of the Inner Harbour (11.2 days median flushing time) (GHD 2023a).

With reference to Figure 4, decreased flushing can potentially lead to increased algal concentrations in these water bodies because of less exchange with lower nutrient and chl-a bay waters. Increased algal levels lead to the following effects and impacts:

- Greater light attenuation through the water column with impacts on:
  - Benthic primary producers via shading (i.e. less light at the seabed through greater absorbance) (Pressure: decreased flushing → Effect: increased algae → Effect: shading → Response: BCH primary production).
  - Aesthetics of the water body via lower clarity (Pressure: decreased flushing → Effect: increased algae → Effect: shading → Response: reduced water clarity).
- Greater organic content of the sediments that leads to Lower DO of the bottom waters with impacts on:
  - Benthic epifauna and infauna (Pressure: decreased flushing → Effect: increased algae → Effect: sediment organic enrichment → Effect: decreased bottom water DO → Response: BCH epifauna and infauna).
  - Increased sediment nutrient fluxes via positive feedback loop (Pressure: decreased flushing → Effect: increased algae → Effect: sediment organic enrichment → Effect: decreased bottom water DO → Pressure: increased nutrients).
  - Increased sediment releases of toxicants (Pressure: decreased flushing → Effect: increased algae → Effect: sediment organic enrichment → Effect: decreased bottom water DO → Pressure: increased toxicants) and contaminants (Pressure: decreased flushing → Effect: increased algae → Effect: sediment organic enrichment → Effect: decreased bottom water DO → Pressure: increased chemical contaminants).
- Increased likelihood of nuisance algal species with potential impacts to:
  - Human health from increased primary and secondary contact risks (Pressure: decreased flushing → Effect: increased algae → Effect: increased nuisance algae species → Effect: increased primary and secondary contact risk → Response: human health).
  - Human health from seafood contamination (Pressure: decreased flushing → Effect: increased algae → Effect: increased nuisance algae species → Effect: seafood contamination → Response: human health).
  - Aesthetics of the water body via formation of surface scums (Pressure: decreased flushing → Effect: increased algae → Effect: increased nuisance algae species → Response: surface scums).

Casuarina Boat Harbour and KBSC marina operations can potentially result in increased nutrient loads. Accidental sullage tank discharge, increased stormwater inputs, vessel washing and recreational use are examples of operational activities with the potential to increase nutrient loads. Again with reference to Figure 4, the pressure of increased operational nutrient loads has the same effect and response pathways as the pressure of decreased flushing.

[5] Time for 63% of the water body to be exchanged with adjacent bay waters.

3.3.1.2 Pressure: increased toxicants

Expansion of existing operations within the KBSC marina footprint and Casuarina Boat Harbour may potentially increase toxicant loads. Increased stormwater inputs and accidental vessel discharges (spills) are examples of operational activities that may potentially increase toxicant loads and resultant toxicity risks to marine organisms (Pressure: increased toxicants → Effect: toxicity → Response: decreased marine organism health).

3.3.1.3 Pressure: increased microbiological contaminants

Expansion of existing operations within the KBSC marina footprint and Casuarina Boat Harbour may potentially increase microbiological contaminant loads. Accidental sullage discharge is an example of such an operational incident. This type of incident can lead to increased human health risks to primary and secondary recreational contact (Pressure: increased microbiological contaminants → Effect: increased primary and secondary contact risk → Response: human health risk) and tainting of seafood (Pressure: increased microbiological contaminants → Effect: seafood contamination → Response: human health risk).

3.3.1.4 Pressure: increased chemical contaminants

Expansion of existing operations within the KBSC marina footprint and Casuarina Boat Harbour may potentially result in increased chemical contaminant loads. Accidental vessel discharge (spills) and increased stormwater inputs are examples of operational activities with the potential to increase contaminant loads. This can lead to increased human health risks from primary and secondary recreational (Pressure: increased chemical contaminants → Effect: increased primary and secondary contact risk → Response: human health risk) and tainting of seafood (Pressure: increased chemical contaminants → Effect: seafood contamination → Response: human health risk). Seafood contamination can also lead to edible fish tainting, and thereby impact this aesthetic value (Pressure: increased chemical contaminants → Effect: seafood contamination → Response: fish edibility).

3.3.1.5 Pressure: increased debris

Expansion of existing operations within the KBSC marina footprint and Casuarina Boat Harbour may potentially result in increased debris from poor vessel and land-based facility housekeeping, and other inappropriate behaviour from users of the facilities. Further, the risk of minor spills also is elevated from increased vessel (and associated) activities within the water bodies. All of these pressures can lead to directly to a response of aesthetics deterioration of the water body (i.e. visual blight).

3.3.2 Potential contaminants of concern

On the basis of the pressure-response conceptual model, the potential contaminants of concern on the basis of operational activities from the KBMS strategic proposal include:

- Nutrients (TP, FRP, NH_X, NO_X, TN) from planned (e.g. fertiliser application and transport to water bodies, decreased flushing) and unplanned (e.g. vessel sullage release) activities. The indicator is for nutrient enrichment from such activities is chl-a, which is selected as an EQG indicator for the EQO of maintenance of ecosystem integrity. Enhanced biological productivity could also lead to greater organic production, settling of organic particles to the seabed and reduced dissolved oxygen in the bottom waters. Therefore, dissolved oxygen is also selected as an EQG indicator for the EQO of maintenance of ecosystem integrity. Supporting analytes including nutrients (i.e. TN), organic carbon and turbidity will also be monitored to inform identification of causes and subsequent management if EQG criteria for chl-a and dissolved oxygen are not met.
- A range of metal and metalloid, and organic contaminants could increase from planned (e.g. decreased flushing) and unplanned (e.g. releases from vessel maintenance facilities, hydrocarbon spills) operational activities. A range of metal/metalloid (e.g. Cd, Cr, Cu, Pb, Hg, Ni, As, Zn) and organic (e.g. benzene, naphthalene) analytes will be monitored in the waters as EQG indicators for the EQO of maintenance of ecosystem integrity. In the sediments, the same metals/metalloid analytes will be monitored, total PAH will be monitored as the indicator

for hydrocarbon spills, and TBT will be analysed to ascertain any legacy issues with this historical vessel anti-biofoulant contaminant. Additionally, the metal and metalloid analytes in waters will serve as EQG indicators for the EQOs of maintenance of primary contact recreational values and maintenance of aesthetic values. Additional organic EQG indicators for the maintenance of aesthetic values (i.e. fish tainting) include a range of organics from potential planned (e.g. pesticide application) and unplanned (e.g. hydrocarbon spills) operational activities.

– The decreased flushing and increased quiescence of the semi-enclosed water bodies of southwestern Koombana Bay could potentially provide conditions that favour toxic phytoplankton. Toxic algal identification and enumeration will be carried out as an EQG indicator for the EQO maintenance of seafood safe for human consumption. Additionally total phytoplankton cell counts are and EQO indicator for the EQOs of maintenance of primary recreation contact values and maintenance of secondary recreation contact values.
– Increased risk of faecal bacteria may occur from natural events (e.g. catchment runoff) and unplanned operational activities (e.g. vessel sullage spills). Faecal coliform monitoring will be carried out as an EQG indicator for the EQOs of maintenance of seafood safe for human consumption, maintenance of primary recreation contact values and maintenance of secondary recreation contact values.

On the basis of the operational activities risk assessment (Appendix A) and the pressure-response conceptual model (Figure 4 in Section 3.3.1), Table 7 provides a high level summary of the basis for the design of the routine monitoring program of this MEQMP to maintain EQOs.

Table 7 ***Summary of EQC indicator types, assessment locations, monitoring period and frequency, and monitoring justification to maintain EQOs***

EQO	EQC Indicator Type	EQC Assessment Location(s)	Routine Monitoring Frequency	Monitoring Justification
Maintenance of Environmental Quality	Surface chl-a	MEPA, HEPA and reference sites	Bi-weekly (Dec.-Apr. at MEPAs and HEPA Inlet), monthly (Dec. Apr. HEPA Bay), and quarterly (May-Nov.)	Surveillance to track potential risk of eutrophication from reduced flushing and contaminants from operations due to KBMS proposal infrastructure
	Bottom water DO			
	Toxicants in water		Quarterly	
	Toxicants in sediment	MEPA and HEPA sites	Every 2 years	Low risk on basis of historical and baseline data so surveillance frequency adequate
Maintenance of Seafood Safe for Human Consumption	Toxic algae	MEPA, HEPA and reference sites	Quarterly (Jan., Apr., Jul., Oct.)	Surveillance to track potential risk of human seafood consumption by contaminants from operations due to KBMS proposal infrastructure
	Microbiological contaminants	MEPA and HEPA sites		
Maintenance Primary Contract Recreation Values	Toxic algae	MEPA, HEPA and reference sites	Quarterly (Jan., Apr., Jul., Oct.)	Surveillance to track potential risk to primary contact recreation by contaminants from operations due to KBMS proposal infrastructure
	Chemical contaminants			
	Microbiological contaminants	MEPA and HEPA sites		
Maintenance Secondary Contract Recreation Values	Toxic algae	MEPA, HEPA and reference sites	Quarterly (Jan., Apr., Jul., Oct.)	Surveillance to track potential risk to primary contact recreation by contaminants from operations due to KBMS proposal infrastructure
	Chemical contaminants	MEPA, HEPA and reference sites		
	Microbiological contaminants	MEPA and HEPA sites		
Maintenance of Aesthetic Values	Visual and odour indicators	MEPA and HEPA sites	Every survey	Low effort surveillance
	Chemical contaminants (fish tainting)	MEPA and HEPA sites	Quarterly (Jan., Apr., Jul., Oct.)	Surveillance to track potential risk of fish tainting by contaminants from operations due to KBMS proposal infrastructure

3.3.3 LEP spatial extents

The EQO for maintenance of ecosystem integrity requires the spatial classification of two LEPs in Koombana Bay and proximal waters, namely:

- Moderate LEP or MEPA for the existing Inner Harbour and Casuarina Boat Harbour, and the proposed KBSC marina. A MEPA classification recognises that the semi-enclosed nature and/or operational activities associated with these water bodies may reduce MEQ on a local scale. As per Section 3.2.3, operational pressures are allowed to cause moderate changes in the quality of water, sediment and biota beyond natural variation in ecosystem processes and abundance/biomass of marine life, but no detectable changes from the natural diversity of species and biological communities.
- High LEP or HEPA delineation will cover the entirety of Koombana Bay and Leschenault Inlet excluding the semi-enclosed water bodies with a MEPA delineation. The Leschenault Inlet has a HEPA designation in recognition of the need to protect ecological function and conservation values (e.g. dolphins, mangroves, samphire, migratory birds) though it is a highly modified water body. Hence, site specific EQC have been developed for this water body (see Section 4.2.2).

3.3.3.1 LEP defined areas

A LEP defined area is a zone to be characterised for environmental quality against pre-determined EQOs and LEPs. There are four (3) MEPA defined areas (Casuarina Boat Harbour, KBSC marina, Inner Harbour) and two (2) HEPA defined areas (Koombana Bay, Leschenault Inlet). These are illustrated on the spatial representation of the EQP in Figure 5.

LEP defined areas clearly delineate responsibility to implement management actions on the relevant management entity as defined in Section 6.4.

Figure 5 illustrates the spatial configuration of the MEPA and HEPA defined areas. All other proximal waters to Koombana Bay, exposed inshore coastal waters and Leschenault Estuary[6] are classified as HEPA with no defined area status. Further, this MEQMP does not establish, evaluate or manage environmental quality criteria associated with any HEPA areas other than Koombana Bay and Leschenault Inlet.

3.3.4 Monitoring sites

3.3.4.1 Monitoring sites within LEP defined areas

Each of the five (5) LEP defined areas have two (2) to three (3) monitoring sites to evaluate compliance with EQC. Indicative locations of monitoring sites within LEP defined areas are illustrated in Figure 5.

3.3.4.2 Reference sites

Two (2) reference sites along the boundary of the Koombana Bay HEPA serve as the basis to establish and to update EQC values. Indicative locations of reference sites are illustrated in Figure 5.

3.3.5 Laboratory

Laboratory(s) used for analysis of water and sediment samples to be NATA accredited with limits of reporting below the relevant EQG values.

[6] Preliminary HEPA classification to Leschenault Estuary set as default.

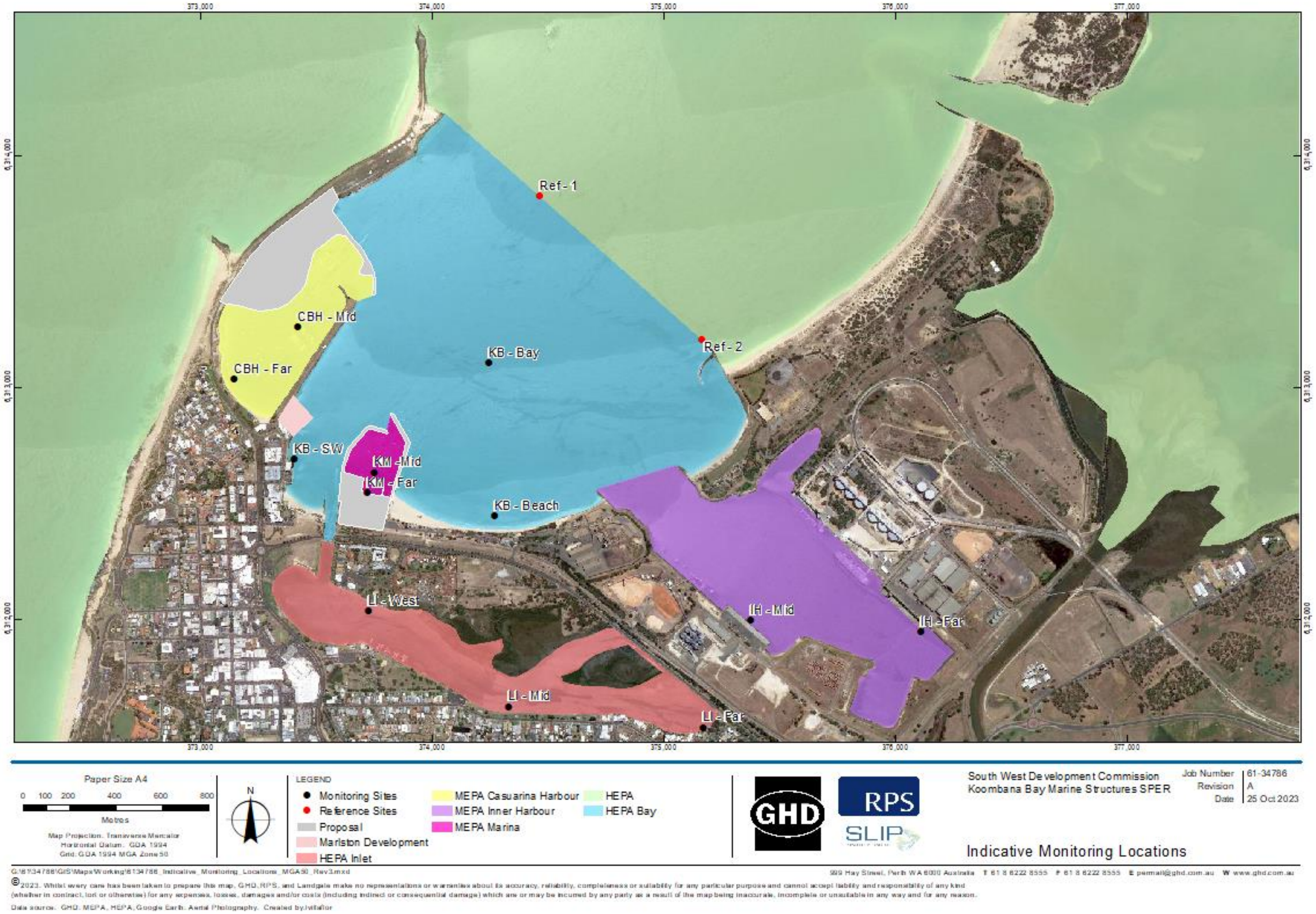

Figure 5 ***Spatial representation of the Environmental Quality Plan with HEPA and MEPA defined areas denoted along with indicative monitoring and reference sites.***

4. Routine monitoring of EQG compliance

This section describes the routine monitoring to verify whether the EQGs for the EQOs are met. Most EQG numeric values are based upon EPA (2016) and EPA (2017) with only the chl-a EQG based on available baseline monitoring data (Section 2.2). The routine monitoring program is partitioned into the following two (2) phases:

- Baseline: Monitoring period to expand the existing baseline dataset prior to the start of construction of the KBSC marina future proposal[7] so as to update EQGs (if needed, via annual review and MEQMP updates as described in Section 6.6).
- Routine: Post-construction monitoring to demonstrate compliance with the EQGs.

A sampling and analysis plan (SAP) to carry out the routine monitoring in terms of pre-survey preparation, field methodology (including field procedures for sample collection, storage and transport), laboratory analysis (including QA/QC), data analysis (including QA/QC) and reporting will be prepared by the MEQMP monitoring service provider(s) prior to implementation.

4.1 Definitions

4.1.1 Median value

Some EQGs are based on the median value at a monitoring site. Three (3) samples (or measurements) will be collected at each monitoring site so that the median value can be determined.

4.1.2 Maximum value

Some EQGs are based on the maximum value at a monitoring site. of the sample data for a defined area. Three (3) samples (or measurements) will be collected at each monitoring site so that the maximum value can be determined.

4.2 EQO maintenance of ecosystem integrity

The objective of the routine monitoring program for the EQO maintenance of ecosystem integrity is to verify that the EQGs have been met in the three (3) MEPA defined areas and the two (2) HEPA defined areas as specified in Table 8. If EQGs within a defined area are exceeded for two (2) consecutive surveys then reactive monitoring and management for the EQO maintenance of ecosystem integrity as per Section 5.1 will be implemented.

4.2.1 Recommended baseline monitoring to reduce predicted environmental quality uncertainty of Leschenault Inlet

Two (2) monitoring programs are recommended to establish the EQG for chl-a of Leschenault Inlet and to improve characterisation of groundwater fluxes into this semi-enclosed water body prior to its construction.

4.2.1.1 Additional baseline monitoring of Leschenault Inlet

There is limited baseline data (Oceanica 2008a, O2 Marine 2021) to establish the EQG for chl-a of the inlet. An additional two (2) years of chl-a (and dissolved oxygen of the bottom waters) data prior to the construction of the KBSC marina will be collected at the inlet to update the site-specific EQG (Section

[7] The Casuarina Boat Harbour northern breakwater will not materially affect flushing of the inlet. Therefore, baseline monitoring of the inlet is acceptable over the period after construction of the Casuarina Boat Harbour future proposal and prior to the construction of the KBSC marina future proposal.

4.2.2). Consideration of the chl-a EQG for different seasons will be evaluated upon completion of the additional baseline monitoring program.

4.2.1.2 Groundwater monitoring of Leschenault Inlet

There is limited information/data to estimate the discharge, and nutrient and contaminant fluxes from groundwater into Leschenault Inlet as identified by RPS (2020). Additional baseline monitoring of water levels, nutrients and contaminants (particularly Zn) are to be carried out for one (1) year prior to the construction of the KBSC marina. Additionally, improved estimates of the groundwater discharge into the inlet are to be made and compared to those of RPS (2020) (see Section 6.5.2.3).

4.2.2 Site specific chl-a EQG for HEPA and MEPA

All EQGs are based on EPA (2017) and ANZG (2018) except for chl-a where:

– The MEPA EQG for chl-a is the 95th percentile (as per Section 3.2.3) of baseline data from reference sites. The **interim** MEPA EQG for chl-a on the basis of available data from locations near the reference sites (Appendix B) is 4 ug/L. The MEPA EQG for chl-a will be applied to the defined areas of the Inner Harbour, Casuarina Boat Harbour and KBSC marina. This interim chl-a EQG will be updated upon collection of two (2) additional years of reference site data.

– The HEPA EQG for chl-a is the 80th percentile (as per Section 3.2.3) of baseline data reference sites. The **interim** MEPA EQG for chl-a on the basis of available data (Appendix B) is 3 ug/L. The HEPA EQG for chl-a will be applied to the Koombana Bay defined area. This interim chl-a EQG will be updated upon collection of two (2) additional years of reference site data.

– The HEPA EQG of Leschenault Inlet for chl-a is the 80th percentile (as per Section 3.2.3) of available baseline data from within this water body. The **interim** HEPA EQG of Leschenault Inelt for chl-a on the basis of available data (Appendix B) is 4 ug/L. This interim chl-a EQG will be updated upon completion of two (2) additional years of baseline monitoring of Leschenault Inlet prior to construction of the KBSC marina (Section 4.2.1.1).

Table 8 Routine monitoring program for the EQO maintenance of ecosystem integrity

LEP Type	EGQ	Pressure or Effect: Parameter(s)	Routine Monitoring Specifications	Frequency
HEPA	**EQG EI HEPA 1KB**: Median chl-a value of each of the Koombana Bay HEPA monitoring sites should not exceed 80th percentile of the reference site data. **EQG EI HEPA 1LI**: Median chl-a value of the Leschenault Inlet HEPA sites should not exceed the 80th percentile of inlet baseline data.	Reduced flushing: c**hl-a** <u>Supporting data</u>: – Acquire vertical profiles of T, S[8], DO and turbidity – Laboratory analysis of TN, LOI[9]	Three (3) surface samples (0.5 m below surface) at: –Three (3) sites within each HEPA defined area –Two (2) reference sites	<u>Baseline monitoring of three (3) inlet sites for two (2) years:</u> Bi-weekly (Dec.-Apr.) to monthly (May-Nov.) at Leschenault Inlet HEPA <u>Routine monitoring</u>: Monthly (Dec.-Apr.) to quarterly (Jul., Oct.) at Koombana Bay HEPA and reference sites Bi-weekly (Dec.-Apr.) to quarterly (Jul., Oct.) at Leschenault Inlet HEPA and MEPA defined areas
	EQG EI HEPA 2: Maximum[10] water concentrations of each of the HEPA monitoring sites should not exceed the following ANZG (2018) default guideline values for toxicants (99% species protection levels except for Co at 95% species protection level): *<u>Dissolved Metals and Metalloids</u>* Cd: 0.7 µg/L Cr III: 7.7 µg/L Cr IV: 0.14 µg/L Co: 1 µg/L Cu: 0.3 µg/L Pb: 2.2 µg/L Hg: 0.1 µg/L Ni: 7 µg/L Ag: 0.8 µg/L V: 50 µg/L Zn: 3.3 µg/L *<u>Organics</u>* Benzene: 500 µg/L Naphthalene: 50 µg/L Pentachlorophenol: 11 ug/L	Increased toxicants in water: *<u>Metals and Metalloids</u>* **Cd, Cr III, Cr IV, Co, Cu, Pb, Hg, Ni, Ag, V, Zn** *<u>Organics</u>* **Benzene, Naphthalene, Pentachlorophenol** <u>Supporting data</u>: As for chl-a and DOC[11]	Three (3) surface (0.5 m below surface) and three (3) bottom (0.5 m above sediments) samples at: –Three (3) sites within each HEPA defined area –Two (2) reference sites	<u>Routine monitoring:</u> Quarterly (Jan. Apr., Jul., Oct.)
	EQG EI HEPA 3: Median of bottom water DO of each of the HEPA monitoring sites is ≥90% saturation	Decreased bottom water DO: **DO Saturation** <u>Supporting data</u>: As for chl-a	Three (3) bottom water measurements (0.5 m above sediments) at: –Three (3) sites within each HEPA defined area –Two (2) reference sites	<u>Routine monitoring</u>: Monthly (Dec.-Apr.) to quarterly (Jul., Oct.) for Koombana Bay HEPA and reference sites

[8] Salinity (S) to be evaluated to gauge if stormwater inputs have a material influence on the inlet via comparison to other MEQMP monitoring sites.
[9] Loss on ignition (LOI) an indicator of potential seagrass wrack effects.
[10] EPA (2017) stipulates 95th percentile. Insufficient measurements to calculate for a defined area during a single survey, hence maximum adopted.
[11] Dissolved organic carbon (DOC) an input into estimation of metal speciation modelling.

LEP Type	EQG	Pressure or Effect: Parameter(s)	Routine Monitoring Specifications	Frequency
				Bi-weekly (Dec.-Apr.) to quarterly (Jul., Oct.) for Leschenault Inlet HEPA
	EQG EI HEPA 4: Median value of a contaminants in the sediments of each of the HEPA monitoring sites should not exceed the following ANZG (2018) default guideline values: *Metals* Sb: 2 mg/kg dry wt; Pb: 50 mg/kg dry wt As: 20 mg/kg dry wt; Hg: 0.15 mg/kg dry wt Cd: 1.5 mg/kg dry wt; Ni: 21 mg/kg dry wt Cr: 80 mg/kg dry wt; Ag: 1 mg/kg dry wt Cu: 65 mg/kg dry wt; Zn: 200 mg/kg dry wt *Organotins* TBT: 9 µg Sn/kg dry wt *Organics*[12] Total PAHs: 10,000 mg/kg dry wt	Increased toxicants in sediments: *Metals and Metalloids* **Sb, As, Cd, Cr Cu, Pb, Hg, Ni, Ag, Zn** *Organotins* **TBT** *Organics* **Total PAH** Supporting data: TOC[13]	Three (3) composite samples at: –Three (3) sites within each HEPA defined area –Two (2) reference sites	Baseline monitoring: One survey prior to construction of first future proposal Routine monitoring: Every 2 years (Jan.)
MEPA	**EQG EI MEPA 1**: Median chl-a value of each of the MEPA monitoring sites should not exceed the 95th percentile of baseline data.	Reduced flushing: c**hl-a** Supporting data: Acquire vertical profiles of T, S, DO and turbidity Laboratory analysis of TN, LOI[9] and DOC[11]	Three (3) surface samples (0.5 m below surface) at two (2) sites within each MEPA defined area.	Routine monitoring: Biweekly (Dec.-Apr.) Quarterly (Jul., Oct.)
	EQG EI MEPA 2: Maximum[10] water concentrations of each of the MEPA monitoring sites should not exceed following ANZG (2018) default guideline values for toxicants (90% species protection levels): *Dissolved Metals and Metalloids* Cd: 14 µg/L; Cu: 3 µg/L; Ag: 1.8 µg/L Cr III: 49 µg/L; Pb: 6.6 µg/L; V: 160 µg/L Cr IV: 20 µg/L; Hg: 0.7 µg/L; Zn: 12 µg/L Co: 14 µg/L; Ni: 200 µg/L *Organics* Benzene 900 µg/L Naphthalene: 90 µg/L Pentachlorophenol: 33 ug/L	Increased toxicants in water: *Metals and Metalloids* **Cd, Cr III, Cr IV, Co, Cu, Pb, Hg, Ni, Ag, V, Zn** *Organics* **Benzene, Naphthalene** Supporting data: As for chl-a	Three (3) surface (0.5 m below surface) and three (3) bottom (0.5 m above sediments) samples at two (2) sites within each of the MEPA defined areas.	Routine monitoring: Quarterly (Jan. Apr., Jul., Oct.)
	EQG EI MEPA 3: Median values of bottom water DO of the each of the MEPA monitoring sites are ≥90% saturation.	Decreased bottom water DO: **DO Saturation** Supporting data: As for chl-a	Three (3) bottom water measurements (0.5 m above sediments) at two (2) sites within each of the MEPA defined areas.	Routine monitoring: Biweekly (Dec.-Apr.) Quarterly (Jul., Oct.)
	EQG EI MEPA 4: Ambient value of a contaminant in sediments from each of the MEPA monitoring sites should not exceed following ANZG (2018) default guideline values (GV-High): *Metals* Sb: 2 mg/kg dry wt; Pb: 50 mg/kg dry wt As: 20 mg/kg dry wt; Hg: 0.15 mg/kg dry wt Cd: 1.5 mg/kg dry wt; Ni: 21 mg/kg dry wt	Increased toxicants in sediments: *Metals and Metalloids* **Sb, As, Cd, Cr Cu, Pb, Hg, Ni, Ag, Zn** *Organotins* **TBT** *Organics* **Total PAH**	Three (3) composite samples at two (2) sites within each of the MEPA defined areas.	Baseline monitoring: One survey prior to construction of first future proposal Routine monitoring: Every 2 years (Jan.)

[12] PAHs indicator of potential minor hydrocarbon spills.
[13] To correct organic contaminant analytes to 1% total organic carbon (TOC).

LEP Type	EGQ	Pressure or Effect: Parameter(s)	Routine Monitoring Specifications	Frequency
	Cr: 80 mg/kg dry wt Cu: 65 mg/kg dry wt *Organotins* TBT: 70 µg Sn/kg dry wt Ag: 1mg/kg dry wt Zn: 200 mg/kg dry wt *Organics* Total PAHs: 10,000 µg/kg	Supporting data: TOC[13]		

4.3 EQO maintenance of seafood safe for human consumption

The objective of the monitoring program for the EQO maintenance of seafood safe for human consumption is to verify that the EQGs have been met in the three (3) MEPA defined areas and two (2) HEPA defined areas as specified in Table 9. If any of the EQGs for a defined area are exceeded then the reactive monitoring and management for the EQO maintenance of seafood safe for human consumption in Section 5.2 are to be evaluated.

Table 9 Routine monitoring program for the EQO maintenance of seafood safe for human consumption

LEP Type	EQG	Pressure or Effect: Parameter(s)	Routine Survey Method	Frequency
MEPA and HEPA	**EQG SSHC 1**: Median toxic algal concentrations at any MEPA or HEPA monitoring site should not exceed the following in any samples: – Alexandrium : 100 cells/L (*A. acatenella, A. catenella, A. cohorticula, A.fundyense, A.lusitanucum, A. minitum, A. ostenfeldii, A. tamiyavanachi, A. tamarense*) – Dinophysis: 500 cells/L (*D. acuta, D. fortii, D. norvegica)* (*Dinophysis acuminate:* 3,000 cells/L) – Prorocentrum: 500 cells/L (*P. lima*) – Gymnodinium: 1,000 cells/L (*G. catenatum*) – Karenia: 1,000 cells/L (*K. brevis, K. brevis-like, K. mikimotoi*) – Pseudonitzchia: 250,000 cells/L *(P. australis, P. pungens, P. turgidula, P. fraudulenta, P. delicatissima, P. pseudodelicatissima)* – Gonyaulax cf. Spinifera: 100 cells/L – Protoceratium reticulatum 500 cells/L (*Gonyaulax grindley):*	Increased nuisance species in water: **Identification and abundance of toxic algae**	Three (3) surface water samples (0.5 m below surface) at –Two (2) sites within each MEPA defined area –Three (3) sites within each HEPA defined area –Two (2) reference sites	<u>Routine monitoring</u>: Quarterly (Jan., Apr., Jul., Oct.)
	EQG SSHC 2: Median faecal coliform concentration in at any MEPA or HEPA monitoring site must not exceed 14 colony forming units (CFU)/100 mL and the maximum from a defined area must not exceed 21 CFU/100 mL measured with the membrane filtration method.	Increased microbial contamination in water: **Faecal coliform**		

4.4 EQO maintenance of primary contact recreation values

The objective of the monitoring program for the EQO maintenance of primary contact recreation values is to verify that the EQGs have been met in the three (3) MEPA defined areas and two (2) HEPA defined areas as specified in Table 10. If any of the EQGs are exceeded then the reactive monitoring and management for the EQO maintenance of primary contact recreation values in Section 5.3 are to be evaluated.

Table 10 Routine monitoring program for the EQO maintenance of primary recreation contact values

<table>
<tr><th>LEP Type</th><th>EQG</th><th>Pressure or Effect: Parameter(s)</th><th>Routine Survey Method</th><th>Frequency</th></tr>
<tr><td rowspan="3">MEPA and HEPA</td><td>EQG PRC 1:
The phytoplankton cell count[14] from a monitoring site, should not:
– exceed 10 000 cells/mL; or
– detect DoH watch list species or exceed their trigger levels.[15]

There should be no reports of skin, eye or respiratory irritation or potential algal poisoning of recreational users considered by a medical practitioner as potentially resulting from toxic algae when <10,000 cells/mL is present in the water column.</td><td>Increased primary contact risk from algal toxins in water:
Algae ID and abundance[16], public complaints</td><td rowspan="3">Three (3) surface water samples (0.5-m below the surface) at
–Two (2) sites within each MEPA defined area
–Three (3) sites within each HEPA defined area
–Two (2) reference sites</td><td rowspan="3">Routine monitoring:
Quarterly (Jan., Apr., Jul., Oct.)</td></tr>
<tr><td>EQG PRC 2: Maximum[10] faecal bacterial content of marine waters from a monitoring site should not exceed 200 enterococci/100 mL.
Increased primary contact risk from microbiological contamination in water:</td><td>Increased primary contact risk from microbial contaminants in water:
Enterococci</td></tr>
<tr><td>EQG PRC 3: Maximum[10] of sample concentrations from a monitoring site should not exceed:
– Sb[17]: 30 µg/L
– Cd: 20 µg/L
– Cr: 500 µg/L
– Cu: 20,000 µg/L
– Pb: 100 µg/L
– Mn: 5,000 µg/L
– Hg: 10 µg/L
– Ni: 200 µg/L</td><td>Increased primary contact risk from chemical contaminants in water:
Sb, Cd, Cr, Cu, Pb, Mn, Hg, Ni</td></tr>
</table>

[14] Including cyanobacteria and eukaryotic organisms.
[15] Detection or exceedance of Department of Health (DoH) WA watchlist trigger levels should trigger re-sampling and a visual assessment of the site within 48 hours for assessment against EQS.
[16] Phytoplankton identification/enumeration also carried for the EQO seafood safe for human consumption routine monitoring.
[17] Analytes highlighted in bold underline are part of the EQO maintenance of ecosystem integrity routine monitoring.

4.5 EQO maintenance of secondary contact recreation values

The objective of the monitoring program for the EQO maintenance of secondary contact recreation values is to verify that the EQGs have been met in the three (3) MEPA defined areas and the two (2) HEPA defined areas as specified in Table 11. If any of the EQGs are exceeded then the reactive monitoring and management for the EQO maintenance of secondary contact recreation values in Section 5.4 are to be evaluated.

Table 11 Routine monitoring program for the EQO maintenance of secondary recreation contact values

Locations	EQG	Pressure or Effect: Parameter(s)	Routine Survey Method	Frequency
MEPA and HEPA	**EQG SRC 1**: –The median phytoplankton cell count from a monitoring site should not exceed 25,000 cells/mL. –There should be no reports of skin, eye or respiratory irritation or potential algal poisoning of recreational users considered by a medical practitioner as potentially resulting from toxic algae when <25,000 cells/mL is present in the water.	Increased secondary contact risk from algal toxins in water: **Algal abundance and public complaints**	Three (3) surface water samples (0.5 m below the surface) at –Two (2) sites within each MEPA defined area –Three (3) sites within each HEPA defined area –Two (2) reference sites	Routine monitoring: Quarterly (Jan., Apr., Jul., Oct.) As public complaints are received
	EQG SRC 2: Maximum[10] faecal bacterial content of marine waters from a monitoring site should not exceed 2,000 enterococci/100 mL.	Increased secondary contact risk from microbiological contamination in water: **Enterococci**[18]		Routine monitoring: Quarterly (Jan., Apr., Jul., Oct.)
	EQG SRC 3: Water should contain no chemicals at concentrations that can irritate the skin of the human body in a defined area.	Increased secondary contact risk from chemical contaminants in water: **Public complaints**	Collate any public complaints reported	As public complaints are received

[18] Enterococci are measured as part of the EQO maintenance of primary recreation contact values routine monitoring.

4.6 EQO maintenance of aesthetic values

The objective of the monitoring program for the EQO maintenance of aesthetic values is to verify that the EQGs have been met in the three (3) MEPA defined areas and the two (2) HEPA defined areas as specified in Table 12. If any of the EQGs are exceeded then the reactive monitoring and management for the EQO maintenance of aesthetic values in Section 5.5 are to be evaluated.

Table 12 Routine monitoring program for the EQO maintenance of aesthetic values

Locations	EQG	Pressure or Effect: Parameter(s)	Routine Survey Method	Frequency
MEPA and HEPA	**EQG VA 1**: Visual and odour indicators within a defined area shall meet following criteria: – **Nuisance organisms**: Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae and sewage should not be present in excessive amounts. – **Faunal deaths**: There should be no reported incidents of large scale deaths of marine organisms relating from unnatural causes. – **Water clarity**: The natural visual clarity of the water should not be reduced by more than 20%. – **Colour**: The natural hue of the water should not be changed by more than ten points on the Munsell scale. – **Surface films**: Oil and petrochemicals should not be noticeable as a visual film on the water or detectable by odour. – **Surface debris**: Water surfaces should be free of floating debris, dust and other objectionable matter including substances that cause foaming. – **Odour**: There should be no objectionable odours.	Decreased aesthetic values from debris, nutrient/contaminant loads and spills: **Visual and odour assessments**	Assessment at each monitoring site	Routine monitoring: Every routine survey
	EQG VA 2: Maximum[10] of fishing tainting substances at a monitoring site should not exceed: – **Cu**[19]: 1.0 µg/L – **Pentachlorophenol**: 0.03 µg/L – Phenol: 0.3 µg/L – Ethylbenzene: 0.25 µg/L – **Naphthalene**: 0.1 µg/L – Toulene: 0.25 µg/L – **Zn**: 5.0 µg/L	Increased fish tainting risk from chemical contaminants in water: **See analytes in EQG to left**	Three (3) surface water samples (0.5 m below the surface) at –Two (2) sites within each of the MEPA defined areas –Three (3) sites within each of the HEPA defined areas –Two (2) reference sites	Routine monitoring: Quarterly (Jan., Apr., Jul., Oct.)

[19] Analytes highlighted in bold underline are part of the EQO maintenance of ecosystem integrity routine monitoring.

5. Reactive monitoring and management for EQG non-compliance

This section describes the reactive monitoring and management actions in the event of an EQG(s) exceedance(s) (Sections 5.1-5.5). Generally, the procedure in the event of non-compliance of an EQG(s) is:

- If non-compliant EQG has an associated EQS then carry out a reactive survey(s) to evaluate compliance of the EQS.
- If non-compliance of the EQS occurs then carry out management actions until EQG met.

5.1 EQO maintenance of ecosystem integrity

Table 14 describes the reactive monitoring and management actions in the event that an EQG(s) for the EQO maintenance of ecosystem integrity is not met in any of the MEPA and/or HEPA defined areas. Figure 6 provides an implementation flow diagram for this EQO.

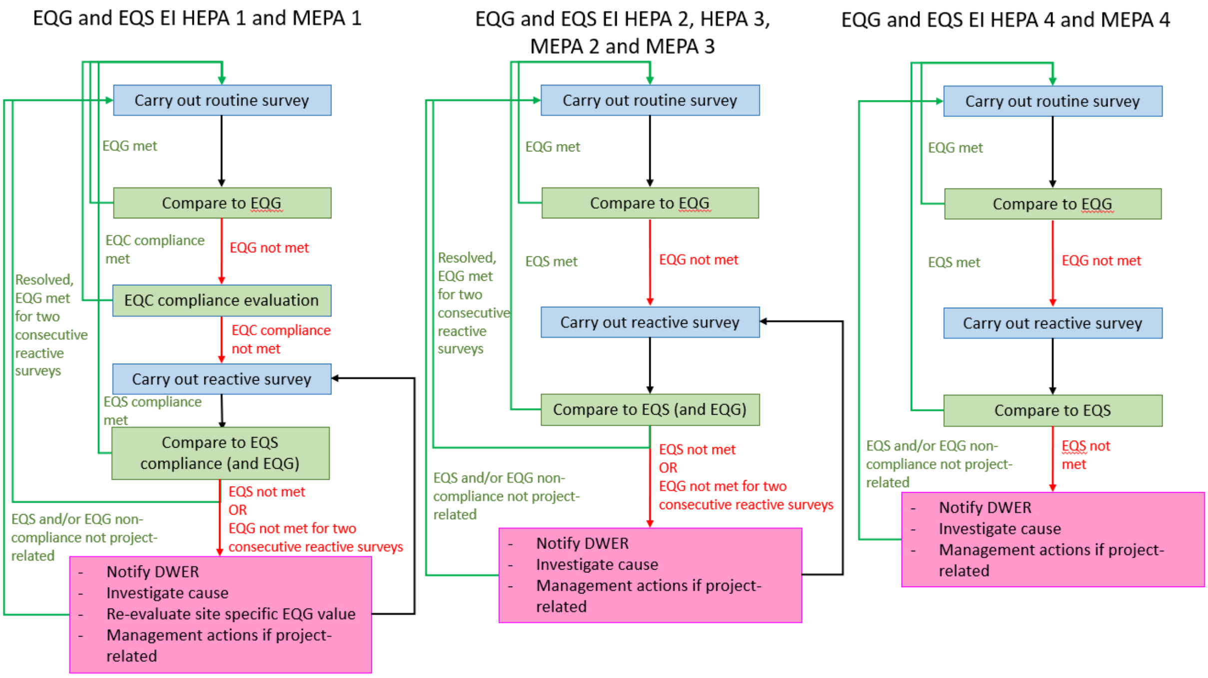

Figure 6 MEQMP implementation flow diagrams for EQO maintenance of ecosystem integrity

Table 13 ***Reactive monitoring program and management actions for non-compliance for the EQO maintenance of ecosystem integrity***

EQP Type	EQG Trigger	EQS	EQC Compliance Evaluation	Management Actions	Reactive Monitoring Specifications
HEPA	EGQ EI HEPA 1KB and/or 1LI not met (site specific chl-a)	**EQS EI HEPA 1KB and/or 1LI**: Exceedance of EQG for at least two (2) consecutive monitoring rounds at the HEPA monitoring site(s).	No reactive monitoring or management action(s) if: – Reference sites do not meet EQG EI HEPA 1KB then a regional or Leschenault Estuary driven phenomenon; OR – MEPA defined areas and reference sites are compliant with EQG EI HEPA 1KB then likely sampling/ laboratory/ transport error or pool of Leschenault Estuary waters.	If EQC compliance evaluation is met then no further reactive monitoring and management. If EQC compliance evaluation is not met then: – Notify DWER of EQG exceedance and EQC compliance evaluation – Carry out reactive monitoring – Investigate if exceedance is project-related (e.g. reduced flushing by KBSC marina) or other (e.g. possibly pool of Leschenault Estuary waters via the Cut) cause, and risk to MEQ – Re-evaluate site specific EQG EI HEPA 1KB and/or 1LI value(s) – If unacceptable risk (e.g. shading by elevated chl-a levels of benthic communities and habitats) to inlet MEQ is project-related (e.g. reduced inlet flushing by KBSC marina) then implement pumping of southeastern inlet embayment waters to Inner Harbour – If needed determine further management responses	Carry out bi-weekly monitoring within the HEPA defined area and reference sites as per routine monitoring specifications for EQG EI HEPA 1KB and/or 1LI until EQG or EQC compliance evaluation is met for two (2) consecutive reactive monitoring surveys then revert to routine monitoring schedule.
	EGQ EI HEPA 2 not met (toxicants in water)	**EQS EI HEPA 2**: Maximum bioavailable contaminant concentration(s) at the HEPA monitoring site(s) should not exceed EQG EI HEPA 2.	Determine bioavailable contaminant metals/metalloids concentrations as follows: – Acquisition of fresh samples and evaluate bioavailable concentrations as per techniques summarised in Table 8.3.3 of ANZECC (2000); OR – Estimates of bioavailable concentrations through speciation modelling by a suitable and qualified practitioner (see ANZECC (2000) section 8.3.5.16).	If EQS EI HEPA 2 met then no further reactive monitoring and management. If EQS EI HEPA 2 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring – Investigate if exceedance is project-related (e.g. reduced inlet flushing by KBSC marina) or other (e.g. river inflow event) cause, and risk to MEQ – If unacceptable risk to inlet MEQ is project-related (e.g. reduced inlet flushing by KBSC marina) then implement pumping of southeastern inlet embayment waters to Inner Harbour – If needed determine further management responses	– Carry out monthly monitoring within the HEPA defined area and reference sites as per routine monitoring specifications for EQG EI HEPA 2 until EQG is met for two (2) consecutive surveys then revert to routine monitoring schedule. – If EQG EI HEPA 2 not met for reactive monitoring survey then determine bioavailable concentrations of samples from reactive monitoring round as per EQC compliance evaluation specifications.
	EGQ EI HEPA 3 not met (bottom water DO)	**EQS EI HEPA 3**: Median of bottom water DO of the HEPA monitoring site(s), calculated over a period of no more than 1 week, should be ≥60% saturation	None	If EQS EI HEPA 3 met then no further reactive monitoring and management. If EQS EI HEPA 3 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring – Investigate if exceedance is project-related (e.g. reduced inlet flushing by KBSC marina) or other (e.g. seagrass wrack decomposition) cause, and risk to MEQ	Carry out monthly monitoring within the HEPA defined area and reference sites as per routine monitoring specifications for EQG EI HEPA 3 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.

EQP Type	EQG Trigger	EQS	EQC Compliance Evaluation	Management Actions	Reactive Monitoring Specifications
				– Evaluate applicable management measures such as: • Removal of seagrass wrack • If unacceptable risk to inlet MEQ is project-related (e.g. reduced inlet flushing by KBSC marina) then implement pumping of southeastern inlet embayment waters to Inner Harbour – If needed determine further management responses	
	EGQ EI HEPA 4 not met (toxicants in sediments)	**EQS EI HEPA 4**: Maximum and median concentrations of bioavailable metal/metalloid and organometallic /organic concentrations, respectively, for the HEPA monitoring site (s), calculated over a period of no more than 1 week, should not exceed EQG EI HEPA 4	Determine bioavailable concentrations for those analytes in non-compliant defined area(s) from stored sediment samples as follows: – Metals/metalloids concentrations via dilute acid extraction. – Organometallic /organic concentrations via organic content normalisation or equilibrium partitioning.	If EQS EI HEPA 4 met then no further reactive monitoring and management. If EQS EI HEPA 4 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring to confirm EQS non-compliance – Investigate if exceedance is project-related (e.g. reduced inlet flushing by KBSC marina) or other (e.g. SPA maintenance dredging) cause, and risk to MEQ – Evaluate applicable management measures such as: • Mapping of unacceptable sediment contamination region(s) and sediment removal – If needed, determine further management responses	– Carry out repeat sediment survey within the HEPA defined area of EQG non-compliance as per routine monitoring specifications for EQG EI HEPA 4 to confirm (or otherwise) EQS EI HEPA 4 non-compliance. – If EQG EI HEPA 4 not met for reactive monitoring survey then analyse bioavailable concentrations of samples as per EQC compliance evaluation specifications.
MEPA	EGQ EI MEPA 1 not met (site specific chl-a)	**EQS EI MEPA 1**: Exceedance of EQG for at least two (2) consecutive monitoring rounds at the MEPA monitoring site(s)	No reactive monitoring or management action(s) if: – Reference sites and Koombana Bay HEPA defined area do not meet EQG MEI MEPA 1KB, then a regional or Leschenault Estuary driven phenomena.	If EQC compliance evaluation is met then no further reactive monitoring and management. If EQC compliance evaluation not met then: – Notify DWER of EQG exceedance – Carry out reactive monitoring – Investigate if exceedance is project-related (e.g. flushing within marina and/or harbour) or other (e.g. vessel sullage) cause, and risk to MEQ – Re-evaluate site specific EQG EI MEPA 1 guideline value – Evaluate and implement applicable management measures such as: • Pumping of Casuarina Boat Harbour and/or KBSC marina to lower concentrations via reduced flushing time and increased exchange with bay – If needed, determine further management responses	Carry out monthly monitoring within the MEPA defined area(s) of EQG non-compliance as per routine monitoring specifications for EQG EI MEPA 1 until EQG or EQC compliance evaluation met for two (2) consecutive surveys then revert to routine monitoring schedule.
	EGQ EI MEPA 2 not met (toxicants in water)	**EQS EI MEPA 2:** Maximum bioavailable contaminant concentration(s) in at the MEPA monitoring site(s) should not	Determine bioavailable contaminant concentrations as follows: – Acquisition of fresh samples and evaluate bioavailable concentrations as per techniques	If EQS EI MEPA 2 met then no further reactive monitoring and management. If EQS EI MEPA 2 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring	– Carry out monthly monitoring within the MEPA defined area(s) of EQG non-compliance as per routine monitoring specifications for EQG EI MEPA 2 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.

EQP Type	EQG Trigger	EQS	EQC Compliance Evaluation	Management Actions	Reactive Monitoring Specifications
		exceed EQG EI MEPA 2.	summarised in Table 8.3.3 of ANZECC (2000) OR – Estimates of bioavailable concentrations through speciation modelling by a suitable and qualified practitioner (see ANZECC (2000) section 8.3.5.16).	– Investigate if exceedance is project-related (e.g. flushing within marina and/or harbour) or other (e.g. vessel maintenance facility) cause, and risk to MEQ – Evaluate applicable management measures such as: • Pumping of Casuarina Boat Harbour and/or KBSC marina to lower concentrations via reduced flushing time and increased exchange with bay – If needed, determine further management responses	– If EQG EI MEPA 2 not met for reactive monitoring survey then determine bioavailable concentrations of samples as per EQC compliance evaluation specifications.
	EGQ EI MEPA 3 not met (bottom water DO)	**EQS EI MEPA 3:** Median of bottom water DO at the MEPA monitoring site(s) , calculated over a period of no more than 1 week, should be ≥60% saturation	None	If EQS EI HEPA 3 met then no further reactive monitoring and management. If EQS EI MEPA 3 non-compliance then: – Notify DWER of EQS exceedance – Carry out reactive monitoring – Investigate if exceedance is project-related (e.g. flushing within marina and/or harbour) or other (e.g. seagrass wrack decomposition) cause, and risk to MEQ – Evaluate applicable management measures such as: • Removal of seagrass wrack. • Pumping to reduce flushing time and potential persistent thermal stratification of Casuarina Boat Harbour and/or KBSC marina – If needed, determine further management responses	Carry out monthly monitoring within the MEPA defined area(s) of EQS EI MEPA 3 non-compliance as per routine monitoring specifications for EQG EI MEPA 3 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.
	EGQ EI MEPA 4 not met (toxicants in sediments)	**EQS EI MEPA 4:** Maximum and median concentrations of bioavailable metal/metalloid and organometallic /organic concentrations, respectively, at the MEPA monitoring site(s) does should not exceed EQG EI HEPA 4	Determine bioavailable concentrations from stored sediment samples as follows: – Metals/metalloids concentrations via dilute acid extraction. – Organometallic /organic concentrations via organic content normalisation or equilibrium partitioning.	If EQS EI MEPA 4 met then no further reactive monitoring and management. If EQS EI MEPA 4 non-compliance then: – Notify DWER of EQS exceedance – Carry out reactive monitoring to confirm EQS non-compliance – Investigate cause of exceedance (e.g. SPA maintenance dredging) – Evaluate applicable management measures such as: • Mapping of unacceptable sediment contamination region(s) and sediment removal – If needed, determine further management responses	– Carry out repeat sediment survey within the MEPA defined area(s) of EQG non-compliance as per routine monitoring specifications for EQG EI MEPA 4 to confirm (or otherwise) EQS not met. – If EQG EI MEPA 4 not met for reactive monitoring survey then analyse bioavailable concentrations from reactive monitoring survey as per EQC compliance evaluation specifications.

5.2 EQO maintenance of seafood safe for human consumption

Table 14 describes the reactive monitoring and management actions in the event that an EQG(s) for the EQO maintenance of seafood safe for human consumption is not met in any of the MEPA and/or HEPA defined areas. Figure 7 provides an implementation flow diagram for this EQO.

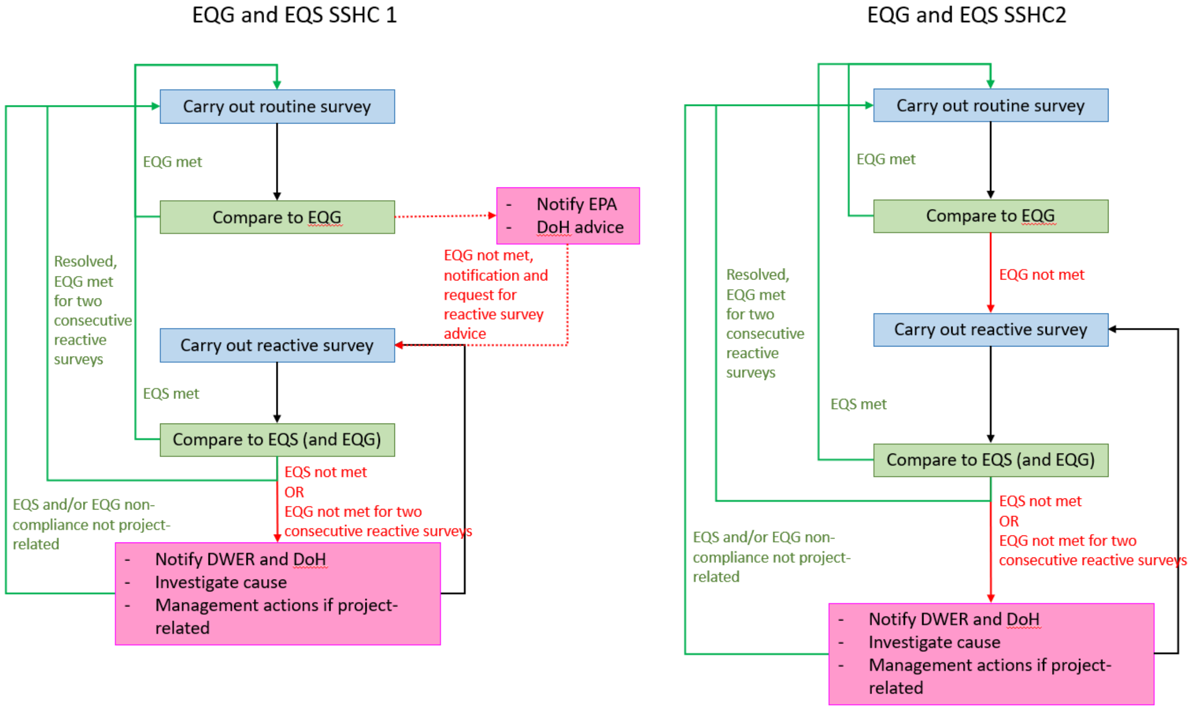

Figure 7 MEQMP implementation flow diagrams for EQO maintenance of seafood safe for human consumption

Table 14 Reactive monitoring program and management actions for non-compliance for the EQO maintenance of seafood safe for human consumption

Locations	EQG Trigger	EQS	Management Actions	Reactive Monitoring Specifications
MEPA and HEPA	EQG SSHC 1 not met (toxic algae)	**EQS SSHC 1:** Toxins in seafood should not exceed the following in any samples: – Paralytic shellfish poison (PSP): 0.8 mg Saxitoxin eq./kg – Diarrhoetic shellfish poison (DSP): 0.2 mg/kg – Neurotoxic shellfish poison (NSP): 200 mouse units/kg – Amnesic shellfish poison (ASP) (domoic acid): 20 mg/kg – Yessotoxins: 1 mg Yessotoxin eq./kg	– Notify DWER of EQG SSHC 1 non-compliance – Request advice from DoH to carry out reactive monitoring survey of algal toxin in shellfish tissue – Carry out reactive monitoring. If EQS SSHC 1 met then revert to routine monitoring schedule. If EQS SSHC 1 not met then: – Notify DWER and DoH of EQS exceedance – Investigate cause of exceedance (e.g. river inflow event) – Determine further management responses if exceedance caused by operations	Carry out reactive monitoring every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance: – As per routine monitoring specifications for EQG SSHC 2 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule – Acquire shellfish samples within the defined area(s) of EQG non-compliance for analysis of algal toxins in accordance with DoH advice
	EQG SSHC 2 not met (microbiological contaminants)	**EQS SSHC 2:** The median faecal coliform concentration in samples from a defined area must not exceed 70 CFU/100 mL and the maximum must not exceed 85 CFU/100 mL measured with the membrane filtration method.	If EQS SSHC 2 met then revert to routine monitoring schedule. If EQS SSHC 2 not met then: – Notify DWER and DoH of EQS exceedance – Investigate cause of exceedance (e.g. river inflow event) – Determine further management responses	Carry out reactive monitoring every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance as per routine monitoring specifications for EQG SSHC 2 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.

5.3 EQO maintenance of primary contact recreation values

Table 15 describes the reactive monitoring and management actions in the event that an EQG(s) for the EQO maintenance of primary contact recreation values is not met in any of the MEPA and/or HEPA defined areas. Figure 8 provides an implementation flow diagram for this EQO.

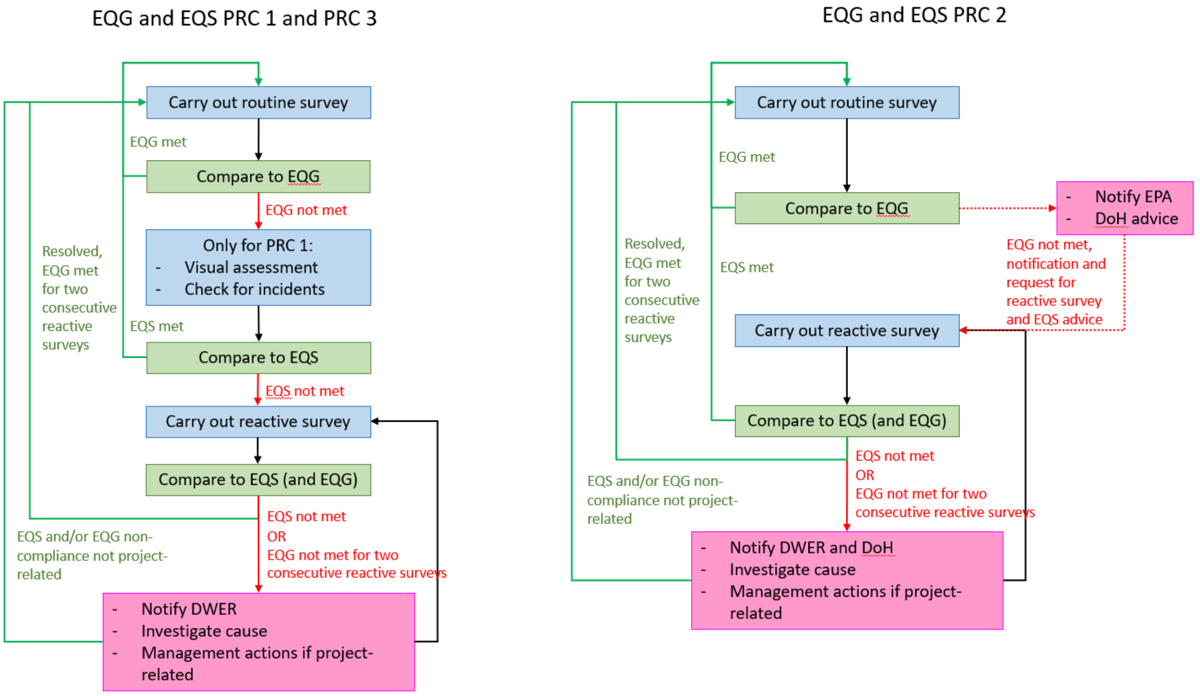

Figure 8 *MEQMP implementation flow diagrams for EQO maintenance of primary contact recreation values*

Table 15 *Reactive monitoring program and management actions for non-compliance for the EQO maintenance of primary contact recreation values*

Locations	EQG Trigger	EQS	Management Actions	Reactive Monitoring Specifications
MEPA and HEPA	EQG PRC 1 not met (phytoplankton cell abundance)	**EQS PRC 1**: – The phytoplankton cell count[20] from a single site, should not: • Exceed 50,000 cells/mL; or • Detect or exceed DoH watch list action levels. – There should be no visual presence of algal scums[21] or relatively widespread visible presence of *Lyngbya ajuscule* filaments (NHMRC 2008). – There should be no confirmed incidences by report from a medical practitioner, of skin, eye or respiratory irritation, caused by toxic algae or of algal poisoning of recreational users.	– Conduct as soon as practicable visual assessment for visible presence – Check for any confirmed incidents of irritation or poisoning If EQS PRC 1 met then revert to routine monitoring schedule. If EQS PRC 1 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring survey – Investigate cause of exceedance (e.g. river inflow event and calm period) – Determine further management responses	Carry out reactive monitoring every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance as per routine monitoring specifications for EQG PRC 1 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.
	EQG PRC 2 not met (microbiological contamination)	**EQS PRC 2**: The maximum faecal bacterial content of marine waters should not exceed 500 enterococci/100 mL	If EQS PRC 2 met then revert to routine monitoring schedule. If EQS PRC 2 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring – Investigate cause of exceedance (e.g. river inflow event) – Determine further management responses	

[20] Including cyanobacteria and eukaryotic organisms.
[21] Algal scums are defined as dense accumulations of algal cells at or near the surface of the water forming a layer of distinct discolouration (green, blue, brown or red) (Gov QLD 2002).

Locations	EQG Trigger	EQS	Management Actions	Reactive Monitoring Specifications
	EQG PRC 3 met (chemical contaminant)	**EQS PRC 3**: DoH to be consulted for advice on setting an appropriate EQS that protects recreational users and any necessary further investigations	– Notify DWER of EQG exceedance – Seek advice from DoH prior to undertake reactive monitoring assessment against EQS – Carry our reactive monitoring If EQS PRC 3 met then revert to routine monitoring schedule. If EQS PRC 3 not met then: – Notify DWER and DoH of EQS exceedance – Investigate cause of exceedance (e.g. site near vessel maintenance facility) – Determine management response and reactive monitoring to potential risk to public health	Carry out reactive monitoring survey(s) every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance as per DoH advice until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.

5.4 EQO maintenance of secondary contact recreation values

Table 16 describes the reactive monitoring and management actions in the event that an EQG(s) for the EQO maintenance of secondary contact recreation values is not met in any of the MEPA and/or HEPA defined areas. Figure 9 provides an implementation flow diagram for this EQO.

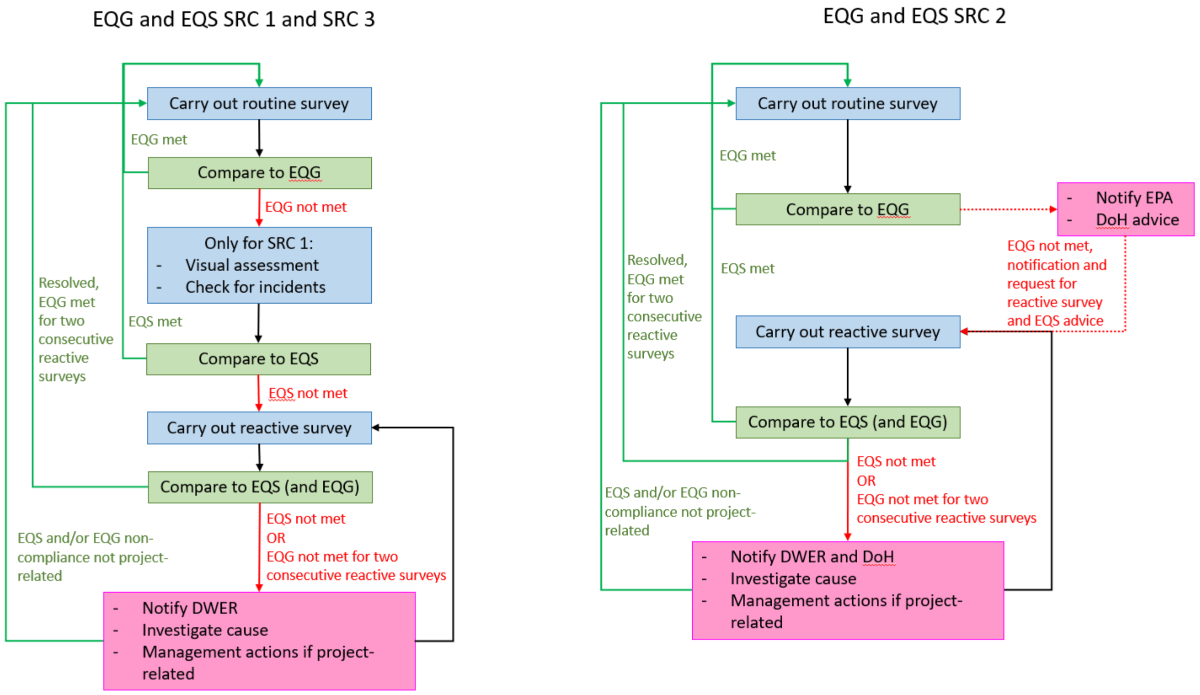

Figure 9 *MEQMP implementation flow diagrams for EQO maintenance of secondary contact recreation values*

Table 16 *Reactive monitoring program and management actions for non-compliance for the EQO maintenance of secondary contact recreation values*

Locations	EQG Trigger	EQS	Management Actions	Reactive Monitoring Specifications
MEPA and HEPA	EQG SRC 1 not met (phytoplankton cell abundance)	**EQS SRC 1**: There should be no confirmed incidences by report from a medical practitioner, of skin, eye or respiratory irritation or poisoning in secondary contact recreational users caused by toxic algae.	Check for any confirmed incidents of irritation or poisoning If EQS SRC 1 not met then: – Notify DWER of EQS exceedance – Seek advice from DoH prior to undertake reactive monitoring assessment against EQS – Carry our reactive monitoring – Determine further management responses to potential risk to public health If EQS SRC 1 met then revert to routine monitoring schedule.	Carry out reactive monitoring survey(s) every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance as per DoH advice until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.
	EQG SRC 2 not met (microbiological contamination)	**EQS SRC 2**: The maximum faecal bacterial content of a monitoring site should not be >5,000 enterococci/100 mL.	If EQS SRC 2 met then revert to routine monitoring schedule. If EQS SRC 2 not met then: – Notify DWER of EQS exceedance – Carry out reactive monitoring – Investigate cause of exceedance (e.g. river inflow event) – Determine further management responses	Carry out monitoring every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance as per routine monitoring specifications for EQG SRC 2 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.

Locations	EQG Trigger	EQS	Management Actions	Reactive Monitoring Specifications
	EQG SRC 3 not met (chemical contaminants)	**EQS SRC 3**: There should be no confirmed incidences by report from a medical practitioner, of skin, eye or respiratory irritation or poisoning in secondary contact recreational users caused by chemical contaminants.	Check for any confirmed incidents of irritation or poisoning If EQS SRC 3 not met then: – Notify DWER of EQS exceedance – Seek advice from DoH prior to undertake reactive monitoring assessment against EQS – Carry our reactive monitoring – Determine further management responses to potential risk to public health If EQS SRC 3 met then revert to routine monitoring schedule.	Carry out reactive monitoring survey(s) every two (2) weeks within the MEPA and/or HEPA defined area(s) of EQS non-compliance as per DoH advice until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.

5.5 EQO maintenance of aesthetic values

Table 17 describes the reactive monitoring and management actions in the event that an EQG(s) for the EQO maintenance of maintenance of aesthetic values is not met in any of the MEPA and/or HEPA defined areas. Figure 10 provides an implementation flow diagram for this EQO.

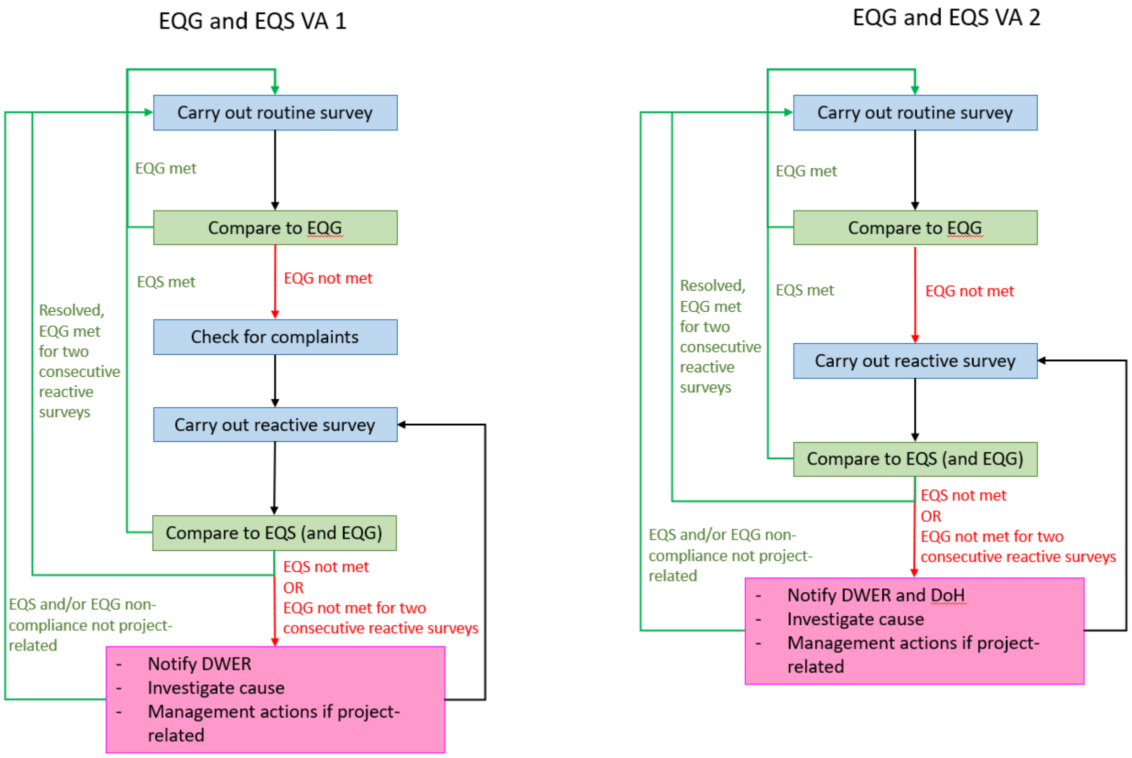

Figure 10 ***MEQMP implementation flow diagrams for EQO maintenance of aesthetic values***

Table 17 ***Reactive monitoring program and management actions for non-compliance for the EQO maintenance of aesthetic values***

Locations	EQG Trigger	EQS	Management Actions	Reactive Monitoring Specifications
MEPA and HEPA	EQG VA 1 not met (aesthetic values)	**EQS VA 1**: There should be no overall decrease in the aesthetic water quality values of Koombana Bay and adjacent water bodies with direct measures of the communities' perception of aesthetic values.	– Undertake reactive monitoring – Collate any complaints regarding aesthetic values and evaluate EQS VA 1 If EQS VA 1 met then revert to routine monitoring schedule. – If EQS VA 1 not met then: • Notify DWER of EQS non-compliance • Identify the causes for deterioration in community perception of aesthetic values • Implement management to prevent further reduction of, and if possible to improve, the aesthetic value within an agreed timeframe • Determine further management responses	Undertake reactive monitoring survey every two (2) weeks in defined area(s) with non-compliant EQG VA 1 as per routine monitoring for EQG VA 1 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule.
	EQG VA 2 not met (fish tainting chemicals)	**EQS VA 2**: There should be no detectable tainting of edible fish harvested from Koombana Bay and its adjacent water bodies.	– Carry out reactive monitoring to confirm presence of fish tainting chemicals and collection of edible fish for taste test If EQS VA 2 not met then: • Notify DWER of EQS non-compliance • Identify the causes for fish tainting • Determine further management responses If EQS VA 2 met then revert to routine monitoring schedule.	Undertake monthly reactive monitoring survey – Resample for EQG compliance in the non-compliant defined area(s) as per routine monitoring for EQG VA 2 until EQG met for two (2) consecutive surveys then revert to routine monitoring schedule. – Collect edible fish and carry out taste testing in the non-compliant defined area(s) and carry out fish tasting to evaluate EQS VA 2.

6. MEQMP implementation

6.1 KBMS management policy

The KBMS Management Policy (Final Version October 2023) underpins the coordination and management of this MEQMP. The management framework of the policy is illustrated in Figure 11.

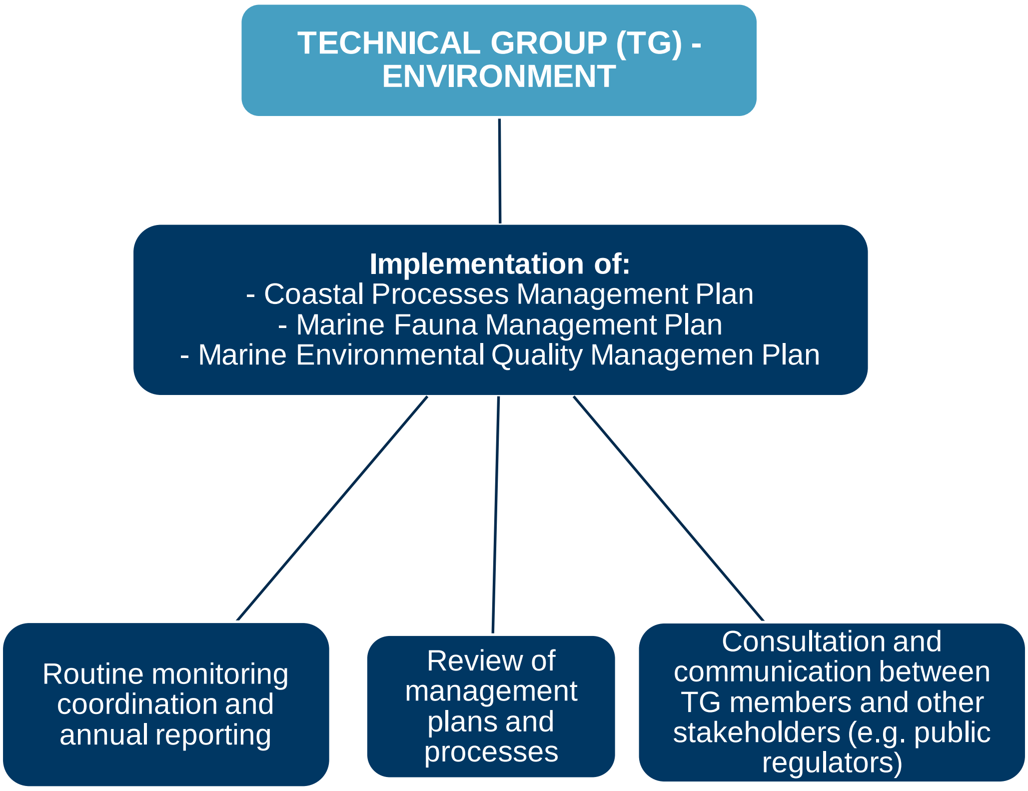

Figure 11 Management framework of the KBMS management policy

The key elements of the policy as they pertain to this MEQMP include:

– Environmental monitoring and management:
  - Environmental impacts are principally managed through implementing the requirements of this MEQMP. It is the responsibility of each proponent to manage their future proposal within the environmental quality guidelines and standards outlined in this MEQMP.
  - Proponents of each future proposal must comply with the conditions of any notice issued under the EP Act as they pertain to marine environmental quality and the monitoring requirements specified in this MEQMP.
  - SWDC (or delegate entity) with advice from the Technical Group will support proponents with regards to routine monitoring coordination, annual reporting and reviews (and updates) of this MEQMP.

– Compliance and reporting:
  - Future proposal proponents must comply with arrangements outlined in this MEQMP and any other management controls imposed by any relevant statutory or government authority in relation to their activities in Koombana Bay. Importantly, it is the future proposal proponent and not the SWDC that is liable for any breaches.
  - The role of SWDC (or delegate entity) is as coordinator of the Framework, and by extension this MEQMP.

– Reviews:
  - The SWDC (or delegate entity) and Technical Group will periodically review the MEQMP (and the policy) to ensure it meets regulatory requirements and community expectations.

The initial review period will be two (2) years (biennial) following commencement of operations of the Casuarina Boat Harbour future proposal (see Section 6.6.1).

6.2 Routine monitoring

Routing (and baseline) monitoring specifications are provided in Section 4. An overview of the routine (and baseline) monitoring schedule is provided in Table 18.

Table 18 Summary of EQG parameters, location, sampling medium and sampling frequency across the two (2) phases of the routine monitoring program

				Baseline Monitoring		Routine Monitoring		
EQO	**EQG Parameters**	**Location**	**Medium**	**Bi-Weekly (Dec.-Apr.), Monthly (May-Nov.) (only INLET sites)**	**Once Prior to Construction of First Future Proposal (ALL sites)**	**Bi-Weekly (Dec.-Apr. ALL sites except HEPA KB and REFERENCE), Monthly (Dec.-Apr. HEPA KB and REFERENCE sites), Quarterly (Jul., Oct. ALL sites)**	**Quarterly (Jan., Apr., Jul., Oct.)**	**Every 2 Years (Jan.)**
Ecosystem Integrity (EI)	Chl-a	HEPA and MEPA defined areas, reference sites	Water					
	DO Saturation							
	Metals & Metalloids (Ag, Cd, Co, Cr, Cu, Hg, Ni, Pb, V, Zn)							
	Organics (Benzene *[BTEX]*, Naphthalene *[PAHs]*, Pentachlorophenol *[Phenols]*)							
	Supporting data: *Analytes: TN, LOI, DOC Vertical water column profiles: T, S, DO, turbidity*							
	Metals & Metalloids (Ag, As, Cd, Cr Cu, Pb, Hg, Ni, Sb, Zn)		Sediment					
	Organotins (TBT)							
	Organics (PAHs)							
	Supporting data: *TOC*							
Seafood Safe for Human Consumption (SSHC)	Identification and enumeration of toxic algae		Water					
	Faecal coliforms							
Primary Recreation Contact Values (PRC)	Algal (Identification and enumeration of algae)		Water				SSHC	
	Chemical contaminants (Sb, As, Cd, Cr, Cu, Pb, Mn, Hg, Ni)						EI	
	Microbiological contaminants (enterococci)							
Secondary Recreation Contact Values (SRC)	Algal (Identification and enumeration of algae)		Water				SSHC	
	Microbiological contaminants (enterococci)						SSHC	
Aesthetic Values (AV)	Subjective visual and odour assessments		Water					
	Fish tainting chemical contaminants (Cu, Pentachlorophenol, Phenol, Ethylbenzene, Naphthalene, Toulene, Zn)		Water				EI	

Colour Code	Description
	Sampling used for EQO
	Partial reliance on sampling from another EQO(s)
	Complete reliance on sampling from another EQO(s)
	Supporting data

6.3 Reactive monitoring and management

Reactive monitoring and management specifications are provided in Section 5.

6.3.1 Management actions

The key management actions following an EQS (or EQC compliance evaluation for EQS EI HEPA 1 and MEPA 1) non-compliance include:

- Reactive monitoring to determine if non-compliance is persistent and ongoing, the effectiveness of management actions, and to inform ongoing management.
- Notifications to EPA (and DoH for health-related non-compliances) as reportable incidents.
- Identification of the likely sources or causes of the non-compliance to inform ongoing management.
- Consultation and advice from EPA (and DoH for health-related non-compliances) on reactive monitoring techniques, adjustment or setting of EQS (particularly DoH for health-related non-compliances), and appropriate management actions.
- Specific management actions may range from enforcement measures (e.g. vessel sullage tank inspections), public mandates (e.g. seafood closure), changes to operations (e.g. fertiliser application on foreshores), or even alteration to infrastructure. Examples of possible management actions are included in the tables in Section 5 under the column ‘management actions’.

6.4 MEQMP coordination and management

The responsible parties for coordination and management of the MEQMP are summarised in Table 19, which is underpinned by the KBMS management policy (Section 6.1).

Table 19 Entities for MEQMP coordination and responsibility of monitoring and management actions

LEP Defined Area	Monitoring and Management Responsibility Entity	MEQMP Coordination Entity
Koombana Bay HEPA	DoT, KBSC	SWDC (or delegate entity)
Inner Harbour MEPA	SPA	
Casuarina Boat Harbour MEPA	DoT	
KBSC Marina MEPA	KBSC	
Leschenault Inlet HEPA		

MEQMP coordination responsibilities by SWDC (or delegate entity) will include , but not be limited to:

- Coordination support to proponents in the implementation of this MEQMP.
- Preparation of annual reports and submission to regulators.
- Reviews and updates to this MEQMP.

MEQMP management responsibilities by the proponents of a future proposal will include, but not limited to:

- Arrangements with service providers to carry out routine and reactive monitoring to industry-level standards (e.g. sampling and analysis plans, field and laboratory QA/QC procedures).
- Carrying out all routine and reactive monitoring activities (e.g. surveys, data, reports, exceedance events), and record keeping of implemented management actions (e.g. documentation, emails, phone logs).
- Carrying out management actions (mitigation measures) arising from EQC non-compliance.
- Carrying out preventative controls arising from prior EQC non-compliance.
- Reporting any EQC non-compliance events that are not captured with this MEQMP’s monitoring regime.

- Provision of community and other stakeholder information regarding marine environmental quality within LEP defined areas of responsibility.

6.5 Reporting

6.5.1 Regulator reporting

6.5.1.1 EQS exceedances

In the event of an EQS non-compliance, DWER will be notified within two (2) days of identification of the exceedance by the relevant proponent with the following information:

- Which EQG exceeded.
- Monitoring data of the routine monitoring survey in question.
- Identification of the potential cause of the exceedance.
- The proposed management response.

A follow-up report will be provided to DWER by the relevant proponent within one (1) month with the following information:

- Corrective actions to meet EQC.
- All monitoring data collected since the exceedance including demonstration that corrective management has been effective.

6.5.1.2 Annual reports

An annual calendar year (1 January to 31 December) report summarising the routine monitoring, and any reactive monitoring and management, will be submitted to DWER by 1 March annually by SWDC (or delegate entity), during both the baseline and verification phases. The annual report will include:

- Documentation of routine and reactive (if any) monitoring that was undertaken over the previous calendar year.
- Comparison of the routine and reactive (if any) monitoring results to the relevant EQGs and EQSs. A ‘traffic light‘ summary will be provided as a simple overall status condition of marine environmental quality compliance to relevant EQC.
- Documentation of any management actions and their effectiveness that were undertaken over the previous year and those extending into the next annual reporting period.

6.5.2 MEQMP coordination

6.5.2.1 Routine monitoring data

Proponents will provide routine monitoring data to the SWDC (or delegate entity) within one (1) month of a routine monitoring survey.

6.5.2.2 Reactive monitoring data and management actions

Proponents will provide to SWDC (or delegate entity) a copy of any follow-up reports and supporting data to DWER in the event of an EQS exceedance (see Section 6.5.1.1).

6.5.2.3 Report of recommended studies

The following reports of recommended additional studies will fill knowledge gaps and improve understanding of the Leschenault Inlet environment:

- Additional baseline monitoring of Leschenault Inlet (Section 4.2.1.1).
- Groundwater monitoring of Leschenault Inlet (Section 4.2.1.2).

6.6 Reviews and updates

6.6.1 Biennial review

On a biennial basis the MEQMP will undergo a review by 1 February with consideration of the following:

- Evaluation of the EQC (e.g. site specific chl-a for EQG EI HEPA 1KB, EQG EI HEPA 1LI and EQG EI MEPA 1).
- New potential or previously unidentified existing threats to marine environmental quality.
- Lessons learned from past monitoring and management actions.

6.6.2 MEQMP updates

Any significant updates to the MEQMP will be submitted to DWER by SWDC (or delegate entity) for approval prior to implementation.

7. References

ANZECC (2000) Australian and New Zealand Guideline for Fresh and Marine Water Quality. October 2000.

ANZG (2018) Australian and New Zealand Guideline for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at ww.waterquality.gov.au/anz-guidelines

Cardno (2021) SAP Implementation Report: Dredge Spoil Sediment Sampling – Koombana Bay Sailing Club Marina Development. Prepared for South West Commission. Job RefCW1168500. Rev0.

Environmental Protection Authority (EPA) (2016), *Technical Guidance: Protecting the Quality of Western Australia's Marine Environment*, [Internet, available: <https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/TechnicalGuidance_ProtectingTheQualityOfWAMarineEnvironment-131216_0.pdf>].

EPA (2017) Environmental Quality Criteria Reference Document for Cockburn Sound (2017), Perth, Western Australia.

EPA (2020), *Statement of Environmental Principles, Factors and Objectives*, version 3.0, April 2020, [Internet, available: <https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Statement%20of%20Environmental%20Principles%20-%2003.04.2020_0.pdf

GHD (2023a) Marine Environmental Quality Modelling. Prepared for South West Development Commission for KBMS SPER. Project Number 6134786.

GHD (2023b) Baseline Water Quality Monitoring. Prepared for South West Development Commission for KBMS SPER. Project Number 6134786.

GHD (2023c) Review of Past Water and Sediment Quality. Prepared for South West Development Commission for KBMS SPER. Project Number 6134786.

GHD (2023d) Coastal Processes Management Plan. Prepared for South West Development Commission for KBMS SPER. Project Number 6134786.

Government of Western Australia (2020), Department of Justice Parliamentary Counsel's Office, *Environmental Protection Act 1986*, [Internet, available: <https://www.legislation.wa.gov.au/legislation/statutes.nsf/main_mrtitle_304_homepage.html>].

Gov QLD (2002). Queensland Harmful Algal Bloom Response Plan. Department of Health: 13. Government of Queensland.

Hearn, C.J. (1983) Seasonal Aspects of the Oceanography of Koombana Bay. Centre for Water Research UWA, Report ED-83-045, April 1983.

Hearn, C.J., J.R. Hunter and M.L. Heron (1987) The Effects of a Deep Channel on the Wind-Induced Flushing of Shallow Bay or Harbor. J. Geophys. Res. 92 (C4):3913-3924.

Hunter, J.R. (1983) Numerical Simulation of Currents in Koombana Bay and the Influence of the Propose New Power Station. Centre for Water Research UWA, Report ED-83-049, April 1983.

Hollingsworth, E. (2006) Dispersion in Sheltered Coastal Waters of Western Australia. Bachelor Dissertation for Bachelor of Engineering in Applied Ocean Science from School of Environmental Systems Engineering, Western Australia.

Huisman, J., Jones, D., Wells, F., & Burton, T. (2008). Introduced marine biota in Western Australian waters. Records of the Western Australian Museum (25), 1-44.

MAFRL (2015) Sediment contaminants monitoring January 2015. Report to South West Development Commission. School of Environmental Science (Report No MAFRL 15-6) Murdoch University. June 2015. RevA.

Met Ocean Solutions (2008) Long Waves at Bunbury: An Assessment of the infragravity wave climate for future Inner Harbour developments. Prepared for the Bunbury Port Authority. October 2008.

MP Rogers (2016) Casuarina Boat Harbour Dye Release Flushing Study – Project Summary. Prepared for the Department of Transport. Doc No R775 Rev1. June 2016.

NAGD (2009) National Assessment Guidelines for Dredging 2009. Department of Environment, Water, Heritage and the Arts. 2009.

NHMRC (2008). Guidelines for managing risks in recreational water. National Health and Medical Research Council, Canberra.

O2 Marine (2021) Sediment and Marine Water Quality Monitoring of the Leschenault Inlet. Prepared for Department of Primary Industries and Regional Development. Report No. R200188Rev2.

Oceanica (2008a) Bunbury Waterfront Project: Stage 1 Marine and Coastal Baseline Studies – Baseline Water Quality. Prepared for Strategen. Report No 580_002/1. September 2008.

Oceanica (2008b) Bunbury Waterfront Project: Stage 1 Marine and Coastal Baseline Studies – Baseline Sediment Quality. Prepared for Strategen. Report No 580_003/1. May 2008.

Oceanica (2011) Alcoa Port Screening Study – Marine Environment Sediment and Mussels Report. Prepared for Alcoa World Alumina Australia. Report No 615_001/1. September 2011.

Oceanica (2016) Ocean Reef Marina Development PER: EQMF, EQC, EQP and Marine EIA advice. Technical Note for Strategen Environmental. 22 March 2016.

RPS (2017a) Proposed Koombana Marina Groundwater Monitoring Results and Potential Nutrient Loading. Letter to the South West Development Commission. 10 March 2017. Ref No EEL16056.063.

RPS (2017b) SAP Implementation Report – Casuarina Harbour. Prepared for Depart of Transport. Doc. No. EEC 16056.006:2. December 2017.

RPS (2020) Groundwater and Nutrient Flux Assessment of Leshenault Inlet, Bunbury. Prepared for the South West Development Commission. 2 April 2020. Ref No EWP16056.600 Rev0.

RPS (2023a) Benthic Communities and Habitat Study. Prepared for the South West Development Commission for KBMS SPER. Ref No EEL16056.A00.

RPS (2023b) Marine Construction Monitoring and Management Plan. Prepared for the South West Development Commission for KBMS SPER.

RPS (2023c) Marine Fauna Management Plan Prepared for the South West Development Commission for KBMS SPER.

SKM (1998) Measurements of Nutrients and Chlorophyll a in Bunbury Harbour. Prepared for the Bunbury Port Authority.

SKM (2002) Measurements of Nutrients and Chlorophyll a in Bunbury Harbour. Prepared for the Bunbury Port Authority.

SKM (2004) Measurements of Nutrients and Chlorophyll a in Bunbury Harbour. Prepared for the Bunbury Port Authority.

SKM (2007a) Biennial Water Quality Monitoring – Harbour Water Nutrients. Prepared for the Bunbury Port Authority. Rev1. 31 January 2007.

SKM (2007b) Maintenance Dredging 2007 – Sampling and Analysis Report. Prepared for the Bunbury Port Authority. Rev0. 13 March 2007.

SKM (2008) Bunbury Port Environmental Management Long-term Monitoring Programme - Baseline Copper Monitoring. Prepared for Bunbury Port Authority. Rev0. 23 September 2008.

SKM (2009) Bunbury Port Environmental Management Long-term Monitoring Programme - Final Baseline Copper and Other Metals Monitoring. Prepared for Bunbury Port Authority. Rev1. 18 December 2009.

SKM (2010) Bunbury Port Environmental Management Long-term Monitoring Programme - Routine Copper and Other Metals Monitoring Feb 2010. Prepared for Bunbury Port Authority. Rev0. 1 April 2010.

SKM (2011a) Bunbury Port Environmental Management Long-term Monitoring Programme - Routine Copper and Other Contaminants Monitoring November 2010. Prepared for Bunbury Port Authority. Rev0. 8 February 2011.

SKM (2011b) Bunbury Port Environmental Management Long-term Monitoring Programme - Routine Copper and Other Contaminants Monitoring June 2011. Prepared for Bunbury Port Authority. Rev0. 26 September 2012.

Wave Solutions (2012a) Technical Report 4: Hydrodynamic and Sediment Transport Modelling (Bunbury Port Berth 14 Expansion and Coal Storage Loading Facility [Assessment No. 1886]). Prepared for Lanco Resources Australia Pty Ltd. Doc. No. 2419-001-003-002. 23 April 2012.

Wave Solutions (2012b) Technical Report 19: Koombana Bay Baseline Marine Monitoring Report. (Bunbury Port Berth 14 Expansion and Coal Storage Loading Facility [Assessment No. 1886]). Prepared for Lanco Resources Australia Pty Ltd. Doc. No. 2636-001-001-001. 21 October 2012.

Wave Solutions (2012c) Technical Report 8: Marine Sediment Sampling and Analysis Report. (Bunbury Port Berth 14 Expansion and Coal Storage Loading Facility [Assessment No. 1886]). Prepared for Lanco Resources Australia Pty Ltd. Doc. No. 2419-005-002-002. 23 April 2012.

WorleyParsons (2017) Water Quality and Flushing Study: Casuarina Boat Harbour. Prepared for the Department of Transport. Doc No 301012-01741-DOT014-CS-REP-0001. 26 April 2017.

Appendices

Appendix A

Operational Activities Risk Assessment

Appendix B

Data for chl-a EQG

Table B.1 Available chl-a data in mg/L (O2 Marine 2021, Oceanica 2008a) to establish interim chl-a value for EQG EI HEPA 1LI for Leschenault Inlet

Date	LI1	LI2	LI3	Reference
9-Jul-07	0.0038	0.005	0.0037	Oceanica (2008a)
18-Sep-07	0.0036	0.0036	0.0032	Oceanica (2008a)
11-Dec-07	0.0028	0.0037	0.0037	Oceanica (2008a)
2-Apr-08	0.0018	0.0016	0.002	Oceanica (2008a)
14-Jan-20	0.003	0.004	0.004	O2 Marine (2021)
19-Feb-20	0.005	0.004	0.004	O2 Marine (2021)
26-Mar-20	0.005	0.002	<0.001	O2 Marine (2021)
29-Apr-20	0.003	0.002	0.001	O2 Marine (2021)
3-Jun-20	<0.001	0.002	0.002	O2 Marine (2021)
3-Jul-20	<0.001	<0.001	<0.001	O2 Marine (2021)
5-Aug-20	<0.001	<0.001	<0.001	O2 Marine (2021)
80th Percentile (EQG EI HEPA 1LI)	**0.004**	**mg/L**		

Table B.2 Available chl-a data in mg/L (GHD 2023b, Oceanica 2008a) to establish interim chl-a values for EQG EI MEPA 1 for 1 for Casuarina Harbour, Koombana Bay Sailing Club Marina and Inner Harbour, and EQG EI HEPA 1KB for Koombana Bay

Date	T4-C	T5-C	Reference
9-Jul-07	0.0015	0.0015	Oceanica (2008a)
18-Sep-07	0.005	0.006	Oceanica (2008a)
11-Dec-07	0.002	0.002	Oceanica (2008a)
2-Apr-08	0.0022	0.0022	Oceanica (2008a)
6-Sep-16	0.0022	0.0022	GHD (2023b)
26-Oct-16	0.001	0.001	GHD (2023b)
14-Dec-16	0.0018	0.0018	GHD (2023b)
17-Jan-17	0.0015	0.0015	GHD (2023b)
22-Feb-17	0.0009	0.0009	GHD (2023b)
30-Mar-17	0.0028	0.0028	GHD (2023b)
26-Jun-17	0.0023	0.0023	GHD (2023b)
4-Aug-17	0.0028	0.0028	GHD (2023b)
31-Aug-17	0.0014	0.0014	GHD (2023b)
28-Sep-17	0.0021	0.0021	GHD (2023b)
80th Percentile (EQG EI HEPA 1KB)	**0.003**	**mg/L**	
95th Percentile (EQG EI MEPA 1)	**0.004**	**mg/L**	

ghd.com

→ The Power of Commitment